Complete in 5 nos.

VOLUME I JANUARY, 1920 NUMBER 1

THE JOURNAL OF RADIOLOGY

PUBLISHED BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

IOWA CITY, U. S. A.

The

JOURNAL *of* RADIOLOGY

Published by the Radiological Society of North America

Volume I — January, 1920 — Number 1

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THE JOURNAL OF RADIOLOGY

The Journal of Radiology appears for the first time with this issue.

The Journal in reality is not something entirely new. It is hoped, however, that it will be possible to present many new features for the further development of Radiology.

The intention of the Journal is to serve the entire medical profession, inasmuch as it is intended to treat *x*-ray, radium and electricity from every possible angle of diagnosis and therapy, thereby correlating more or less the various phases of diagnosis and treatment.

The Journal will be owned, controlled and published exclusively by the members of the Radiological Society of North America.

The Journal of Radiology earnestly solicits the coöperation of the entire medical profession, as the progress of this science necessarily concerns each and every medical individual.

We do not wish to feature Radiology as an individual branch of medicine, but only as an indispensable essential to the collective phases.

THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

WILL MEET FRIDAY AND SATURDAY APRIL TWENTY-THIRD AND TWENTY-FOURTH 1920 JUST PRECEDING THE AMERICAN MEDICAL ASSOCIATION MEETING IN NEW ORLEANS HEADQUARTERS SCOTTISH RITE CATHEDRAL

Make
Reservations
Early

THE RADIOLOGICAL SOCIETY EXTENDS A CORDIAL INVITATION TO ALL GRADUATE PHYSICIANS INTERESTED IN THE SUBJECT OF RADIOLOGY TO ATTEND THIS MEETING AND TO EXHIBIT ANY NUMBER OF PLATES LANTERN SLIDES OR PRINTS OF INTEREST

RADIUM AND ROENGTEN TREATMENT IN MALIGNANCY

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The reason for incompetent therapy is that many are just beginning to use radium and in so many places the roentgen rays are employed by inexperienced operators. While radiotherapy is not a new subject it is new to many, and for some reason or other it seems to be a difficult subject to master. Of course some are taking up this line of work without any, or with very little, preparatory study of either agent or malignancy itself. A comprehensive study of malignancy is essential to either surgeon or radio-therapeutist before he treats malignant growths. He should know the origin of the growth, its type, duration and mode of extension, also the cause of death, in order to give the patient the greatest amount of palliation in hopeless cases. A good surgeon very often does very poor work in this line just the same as a good roentgenologist along other lines does very poor therapy.

It is true that a large percentage of malignant cases are not treated intelligently either surgically or radiotherapeutically. Today many are giving radiotherapy as a placebo when real treatment is needed, and many are operating on cases past the borderline where surgery is contraindicated, making their patients worse instead of even giving palliation. The treatment of malignancy is really a specialty in itself, at least from the clinical and consultant side. A surgeon may be able to operate after consulting with some one who has had clinical experience, the same as a radiotherapeutist may be able to give the treatment after con-

sulting with some one of experience; in fact, the treatment of malignancy is a side issue with most surgeons and radiotherapeutists. Many of them know very little about metastases and a large proportion do not know whether operation is indicated or not. This is shown by the number of recurrences following early operations and the futile attempt to remove borderline and advanced cases. Some surgeons and roentgenologists who have better judgment are realizing this fact. Inefficient treatment has so often led to a fatal ending that no one inexperienced should employ any method of treatment for even the smallest lesion, no difference whether it is a superficial epithelioma, a tumor of the breast or ulceration of the cervix.

It is a well known fact that cutting out the center of a malignant growth is poor surgery, the same as radiotherapy is useless in the treatment of a local lesion, omitting the lymphatic chains which have metastasized. Eradicating every malignant cell is always a difficult problem by any method. Most radiologists as well as most surgeons are satisfied with the removal of the visible part of the disease, thereby losing valuable time and often allowing a patient to pass from a curable into an incurable state. In fact, too many have been satisfied with their own method of treatment. We have not found the real cure for cancer, but really the only step in advance during the last quarter of a century has been radium and the roentgen rays. Ultra radical operations for recurrences are seldom ever indicated. Raying should be done in order to stop cancer cell proliferation, and if all the cancer cells cannot be eradicated by radiation, then the remaining latent cancer tissues should be removed surgically or by electric-coagulation. In such cases, treatment of the lymphatics is very important and must be done by large quantities of radium or heavy filtered rays with the proper amount of crossfiring.

Those treating malignancy might be divided into three classes; viz, those who treat the local lesion or growth poorly; those who treat the local lesion properly, but omit

or have treated carelessly the metastatic glands; and those who treat the local growth properly but see that the adjacent lymphatics receive the most efficient radiation possible. There are comparatively few in the latter class. Even some surgeons of reputation after operation will send the patient home with a letter to the family physician stating that the patient should receive a Coolidge *x*-ray treatment over the line of incision once a month for six months, omitting so many lymphatics which in most cases contain cancer cells or will later metastasize. Such treatment is not only useless but there is danger of a roentgen dermatitis occurring by offering such poor advice. This is a daily occurrence. But whose fault is it for such bungling roentgen work? It is because so many give such treatment, and it is incumbent upon us, not the surgeon, to advise the proper radiation. If every one were as careful about his technic as the surgeon is with his aseptic precaution before, during and after operations, the end results in malignancy would be different. The treatment of a local growth depends on the nature and situation of the lesion as well as its stage.

Metastases and the lymphatics have been more thoroughly understood in late years as the result of investigations of Hanley. He studied the process particularly in connection with cancer of the breast, but the conclusions arrived at may be referred to other organs as well. In studying the method of cancer cells spreading to the lymphatic glands, the normal physiological relationship of the affected organ to the lymphatic system must be remembered. It has been demonstrated that the lymphatic vessels arising in tissue are not all intercepted by the nearest group of glands; the first set may be not invaded and the cancer cells enter the glands of a more distant group. It cannot be said positively of any malignant growth, however early, that it has not yet produced metastases in the glands. This fact has a most important bearing on the treatment of carcinoma. Therefore, the importance of the exact knowledge of the distribution of the lymphatic vessels and glands cannot be

overestimated. We have no means of determining the limitations of metastases and the extent of invasion of the lymphatic vessels. In practice, we must regard every case of cancer as one in which the lymphatic glands may be affected and give radium and roentgen treatment accordingly.

While it is, therefore, universally conceded that either radium or the roentgen rays is the method of choice in the treatment of epithelioma, yet radium has certain advantages, one being that radium can be inserted into the diseased tissue. Superficial epithelioma of the upper part of the face, before it involves cartilage or bone, is very amenable to radiation, but when the tissues are infiltrated it is more difficult to secure healing which will be permanent. When an epithelioma is situated on the mucous membrane it is more resistant to treatment and the glandular tissue is invaded early. If caustics have been employed, the cartilage is usually involved and it is much more resistant to treatment, and recurrence is more likely. Then, radiation to be successful must be thorough, and it requires more intensive radiation. Here, inserting radium needles is very valuable. When a case is clinically cured, unless the scar is smooth and pliable, there will nearly always be a recurrence. In these cases more radiation must be given or else the unhealthy scar be removed by some other method.

When epithelioma of the lower lip, both early and late, are treated thoroughly by radiation, the treatment including both sides of the neck, equal or better results are obtained than by extirpation. Epithelioma of the lower lip is a serious condition, and radiation, when employed, must be given in such a manner as to destroy all cancer cells in the local lesion and the adjacent lymphatics. When so given, over 90 per cent of the early cases should be cured without producing any deformity, more advanced cases are cured and the hopeless cases receive more palliation than by any other method.

The objection to surgical removal is the frequent recur-

rence in the scar, because the operation on the glands cannot be sufficiently complete, no matter how thoroughly the dissection has been carried out. The removal of the submental, part of the parotid, submaxillary and all the glands which metastasize together with the ligation and excision of the jugular is no easy task; besides cancer cells are often left in deeper glands which cannot be reached. This may seem very radical to those who do not know what has been accomplished by radiotherapy and likewise to those who are not familiar with results in early surgical removal, even when radically performed. It has been shown that a recurrence takes place in over 50 per cent of the cases in which there are no palpable glands at the time of operation, and in over 75 per cent in which there is any glandular involvement whatever.

The results of radium therapy of buccal lingual and pharyngeal cancer are ofttimes brilliant and other times disappointing. Experience warrants the consideration of radium in every case, whether alone in small lesions, as an anti-operative procedure or as a palliative method in hopeless cases. Since the smallest lesions are so prone to recur locally and the adjacent glands so early invaded, radiotherapy should follow even the excision of the smallest growth. In malignant growths in the mouth and throat, the writer has found that the best end results are produced when caustic doses of radium are used with radiation of the lymphatic glands to be followed by electric coagulation of the local lesion. The advantages of electric coagulation are the destruction of tissue without opening the blood and lymph vessels, and the prevention of dissemination which might occur with a cutting operation. The large amount of carcinomatous tissue which can be destroyed by electric coagulation without hemorrhage is an item of great importance, and compels serious consideration by those who have treated many malignant cases. Burying radium needles in lesions of the mouth and throat is a very valuable method of treatment and lately I have had curved needles made for this purpose.

Percentage of cures of cancer of the cervix by operation are disappointingly low, while the results by operation in carcinoma of the fundus are very good. During the last few years it has been realized that cures by the standard hysterectomy are comparatively few and that the high mortality restricts the usefulness of the Wertheim or radical operation. It has been stated that not more than 15 per cent of the cases of cancer of the cervix come early enough to be benefited by the standard operation; that is, before induration of the broad ligaments or extension of the disease into the pelvic glands has taken place, and in only sixty to seventy-five per cent it is justifiable to do a radical operation. When these facts are considered and since radium has become of such service both as a curative and palliative agent, we must pay more attention to this branch of therapy, because there will be only a very few gynaecologists give the subject sufficient attention to do competent work. A review of the literature will show that the most efficient treatment is not being given. The radium work done by the different operators might be compared to a standard hysterectomy where only early cases are cured by local application of a small amount of radium, and to the radical operation where more advanced cases are cured, not only by treating the local growth, but the abdominal and pelvic glands, by large quantities of radium or by from twenty-five to fifty *x*-ray treatments. A radium plaque containing a few radium tubes placed over the lower abdomen or three or four roentgen exposures is certainly very incompetent treatment.

Extension of the cancer cells into the perametrium and pelvic lymphatics from uterine carcinoma has been studied by many and in giving a prognosis as well as in giving the treatment, the importance of cancer dissemination must not be overlooked. Recent studies have shown there is no dependable relation between the size of the primary growth and the presence or absence of metastases. It has been stated that in forty per cent of inoperable carcinoma of the

cervix the pelvic nodes are free from metastases. This would account for some of the brilliant results, because even local radium treatment properly given appears to destroy cancer cells at a greater distance than can be reached surgically. Janeway states: "Our present evidence indicates that radium destroys the disease at a greater distance than the knife is capable of removing it, and does this with no risk or inconvenience to the patient." Kelley states: "Recent studies have shown that in from thirty to fifty per cent of operative cases of cancer of the uterine cervix the disease has formed metastases into the pelvic nodes." Similar statements have been made by other surgeons. Since it is the general opinion that the removal of the pelvic lymph nodes has very little curative value, we should develope an efficient method of radiating the lymphatics. Unfortunately, we are unable by any clinical test to determine whether or not there is an extension into the pelvic lymphatics. Therefore, the only safe procedure is to ray the pelvic glands in all cases of the stage of the disease.

Radium is indicated as a palliative measure for hopeless inoperable and recurrent cases, for operable cases when operation is contra-indicated and prophylaxis after surgical removal. Lately radium is being used by some for primary cases in carcinoma of the cervix when the disease extends into the cervical canal, because nearly all these cases are followed by recurrence, even in the early cases. These cases can be promptly cured by radium, and time alone will tell whether radium alone, without operation, is advisable.

Radium is a specific palliative in inoperable cancer of the uterus. It will clinically cure about one-third of the cases and subjective improvement is noticed in a certain percentage of the others. However, recurrence takes place in many of these clinically cured cases within two or three years. The patient during this time regains normal health and can lead a useful life. If a recurrence takes place, as a rule the patient suffers little in comparison with those who had no radium treatment. In these hopeless cases, the of-

fensive discharge and hemorrhage usually completely disappears within from two to four weeks. The cessation of discharge, which often is so offensive to the family and even to the patient, is a remarkable feature. The local condition changes in character within from two to four weeks after the treatment: the mass begins to contract and shrink, and continues to decrease in size. This is more marked in some cases than in others, the growth having entirely disappeared within two months. Today most surgeons consider the operation incomplete, except in the very early cases.

The prognosis and treatment of cancer of the breast is difficult. The questions arising are mainly three: If the growth disease runs a natural course, how long will the patient live? After removal surgically, what is the chance of recurrence? How many more cases can be cured by employing radium or the roentgen rays as an antioperative or post-operative procedure, and how much palliation can be given by competent radiation in inoperable cases? Without treatment the natural course of the growth depends on whether it is of the medullary or schirrus form. The former will usually terminate in a few months, while the schirrus cancer develops slowly and the expectation of life is at least from two to four years. A prognosis of non-recurrence after operation depends on the stage of development as well as the form of tumor at the time of operation. Today many are operating on advanced cases and expect the same results that the leading authorities claim in early cases. Except in the very early cases where the disease is localized in the breast, the outlook is hopeless as far as the end results are concerned, and today it is a question whether operation does not hasten rather than retard the process when a cure cannot be obtained surgically.

The surgical opinion is that, with a small localized mass in the breast, the patient can be assured that a cure can be expected in four out of five cases; that is, when there is a microscopic freedom of cancer cells found in the adjacent

lymphatics. When the adjacent lymphatics are found to contain cancer cells microscopically, the chances of a cure are at once diminished to one in five. When you state that cancer is found only by the microscope, that is an entirely different proposition from the cases where the axillary glands are palpably enlarged from metastases, because in the latter case the cancer growing edge is away beyond the reach of the knife. Until this is universally recognized by both the surgeon and radiotherapeutist and the patients are treated accordingly the highest percentage of cures will not be obtained or the greatest amount of palliation will not be given to the patient. When the cancer growing edge has reached beyond the surgical mark the patient may be cured by anti-operative radiation. Halstead found death from metastases in 32.4 per cent of the cases even with a microscopically negative axilla. This should be sufficient to show every radiotherapeutist how incompetent a few treatments over the line of incision, axilla and supra-clavicular glands are, and to show the surgeon that they cannot expect a cure surgically when the cancer growing edge is beyond the reach of the knife. Therefore, in anything except the very early cases radiotherapy is the most important part of the treatment. It has taken a long time for both to realize this fact. It is also realized that our present day therapy as it is generally given has only a slight palliative effect, and until better therapy is done the best end results will not be obtained. At least twenty per cent of the cases that reach the three year limit die later of recurrence.

It is difficult to determine the real value of anti- or post-operative radiation because so much of the work has been done in such an incompetent manner and there is no way to visualize or palpate all of the metastases at the time of operation. But it is beyond dispute that a patient is in better shape for operation after cell proliferation is checked by radiation and that many recurrences are prevented by competent radium or roentgen treatment after operation. The marked palliation in hopeless and recurrent cases is

appreciated by everyone. Therefore, radiation has taken a very important place in the treatment of carcinoma of the breast, and we should see that more competent work is done. The cancer-bearing area or microscopic edge of cancer of the breast is often from one and one-half to two feet extending from neck downward. It must be remembered that there are twenty or more lymphatic chains connected with the breast which will later metastasize if the cancer cells have not all been eradicated.

In an article published, "The Post-Roentgen Treatment of Carcinoma of the Breast", read before the American Roentgen Ray Society, New York City, September 22, 1917, I described the areas or lymphatics which should receive treatment together with the technic used at that time. At present slightly more skin areas are employed and in many cases six and ten millimeters of aluminum are used instead of four and the axillary and sub-clavicular glands are treated with a number of radium tubes, the reason for which will be described later.

The technic in the treatment of malignancy is far from being perfect. We have been trying to develop a method by which all cancer cells can be eradicated in every case. Such is hardly possible, but there still remains much to be done. Each year we are treating successfully cases which did not respond to our former treatment. Improvements in methods have made treatment of every type of malignancy, ranging from a superficial epithelioma to carcinoma of the breast or uterus, more efficient.

It is indeed much more rare to see a roentgen ulcer produced than was when everyone who had a machine treated epitheliomas. But we do see many cases of epithelioma, particularly of the mouth and throat, which have been treated in a careless manner either radiotherapeutically or surgically, thereby losing valuable time and often tissue changes taking place which makes further treatment useless. It must be remembered that normal tissue will stand just so much radiation and it can be repeated only a few

times. The following case will illustrate: A patient had carcinoma of the throat and was treated externally by roentgen rays by two different operators, each claiming to have given a full erythema dose within two weeks and no treatment was given to the local growth. So when he came under my care, I could not safely treat the glands of the neck. Only the local lesion in the throat was treated which disappeared within four weeks, but while I was waiting for a severe reaction from the x-ray treatment, a gland enlarged at the angle of the jaw. These two x-ray treatments were inefficient because no reaction appeared and the hair was not removed.

Burying radium and the proper use of electric coagulation have changed the results in cancer of the mouth and throat; but the question arises, should either be done until the lymphatics of the neck be treated by surface applications of radium to check cell proliferation. It is a question whether the deep glands containing metastastic cancer are sufficiently influenced by the ordinary roentgen rays or radium treatment and by the usual amount of crossfiring. It is true that it requires a large amount of radiation to cause the disappearance of all cancer cells even in the lymphatic glands, rather superficially situated in the neck or axilla. The treatment ordinarily given will stop cell proliferation but, if the glands are removed and examined, a latent cancer is found.

By using ten millimeters of aluminum and by using the highest possible penetration, superficial nodules will disappear that are only reduced in size under ordinary treatment. The same is true by using a number of radium tubes so placed as to give rather homogeneous radiation, as the radiation comes from many points instead of a focal point as it does with a roentgen tube. This is a method of crossfiring and is useful in treating glands in the neck and under the clavicle where crossfiring from a single focal point is difficult. There is less loss from absorption from a filtered radium pack than there is from our present day Coolidge

tube. The treatment of the lymphatic glands which are known to metastasize is a difficult task and one which has not received sufficient attention. It has become generally recognized that it requires more radiation to destroy cancer cells than it does to destroy sarcomatous tissue and that squamous carcinoma is not affected by the same amount that will destroy basal cell carcinoma.

X-RAY TREATMENT OF MALIGNANT GROWTHS

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Recent correspondence by the author with leading radiotherapeutists throughout the United States has shown such a wide variety of technic in use in deep therapy treatment that it is the desire of the author to try to standardize the technique for this kind of treatment. Out of the replies which have been received, only three men are using as heavy filtration and as high voltage as the author. We shall take up the matter of technique in detail later in the body of the paper, using the correspondence mentioned above, together with the experience of the author as a foundation for the conclusions.

The prevalence of malignant growths in the United States seems to be on the increase. Whether this increase is real or apparent is doubtful in my mind. There is a chance for a legitimate increase in the percentage due to the fact that the profession is making a more earnest endeavor to make an early and correct diagnosis in malignant diseases and also to the fact that the laity is being educated by widespread propaganda to the importance of going to the physician early in the case of new growths. Whether this increase is real or apparent, it calls to our attention the importance of the treatment of these conditions so that the utmost skill of the medical profession should be marshalled to combat this scourge.

The fact that malignant growths are as a rule well nourished, makes their destruction more difficult than it would otherwise be; especially when one is using physical means to combat them should this fact be borne in mind constantly. Due to the vascularity of malignant growths there are large

clusters of cells lying between the branches of the arteries which are practically surrounded by circulating blood. These cell nests, as ably demonstrated under the microscope by Holding and others, are the last part of the new growth to die. These cell nests are so small that they cannot be seen by the naked eye. Even when the new growths appear entirely healed on the surface, as long as these nests remain unkilled, we will have a recurrence just as certainly as night succeeds the day.

Roughly speaking then, new growths are made up of a vascular structure around which is superimposed the parenchyma. Due to this structural composition of the new growth it is especially vulnerable to the action of radium and *x*-ray. The histological action of both of these agents where proper technique is used, is the same. Both result first, in the destruction of the cell nucleus, producing a cloudy swelling in the nucleus and rupturing of the nuclear membrane with loss of the identity of the nucleus and cloudy swelling of the entire cell, followed by disintegration of the cell itself. These dead cells are probably carried away by the action of the phagocytes and are excreted from the blood through the urine. In cases following massive radio-therapy, it is probably this heavy load of proteid material thrown into the circulation which produces the acidosis called to our attention a number of years ago by Sidney Lange.

In addition to this action of the *x*-ray and radium upon the cell structures of the new growth, we have another action upon the vascular structure of the new growth. This is manifested most noticeably in the small arterioles. The action is noted by an intense swelling of the endothelial lining of the arterioles so that the lumen of the vessel is much reduced in size and in the case of the terminal arterioles the lumen is entirely obliterated, resulting in an endarteritis obliterans. It is well for us to have these histological actions of radio-therapy so indelibly printed on our memories that when treating a case we can visualize the picture.

Since the above action of the *x*-ray and radium has been definitely proven by the microscope and since we know the structure of the new growth to be as outlined above, there are certain fundamental principles which we can lay down and to which we must adhere in the treatment of these enemies of the human mechanism. One of these principles is that we must kill the growth or it will kill the patient. This is an immutable law and there are no exceptions. This rule will hold no matter whether we are using radio-therapy, surgery, chemical caustics or what not.

Since this paper has to do chiefly with the radio-therapeutic treatment of malignant growths, let us lay down another fundamental rule to be followed when this therapeutic means is employed. That is, we should administer the dosage which experience has proven will kill the growth and then for safety sake add as much more. This massive dosage is justifiable in the treatment of malignant growths but is not justifiable in the treatment of benign conditions. So far as I am able to gain information from the experience of radium-therapeutists and from my own personal observation, it is really this massive dose technique which has given radium its success. Many times I have had radium therapeutists tell me that they always produce a burn in the treatment of malignant growths but that this burn heals quickly.

This brings us to the discussion of the proper technique for deep roentgen therapy. I feel that we can learn a lesson from the radium therapeutists in giving massive doses of highly filtered rays. Every physician who has studied the question of technique in roentgen therapy of malignant growths has admired the results obtained by Pfahler of Philadelphia. A number of years ago I became an ardent admirer of him and learned from him the technique which he was employing. At that time I was failing in a percentage of cases in which I thought success ought to be obtained. I immediately went home and taking those same patients applied the technique followed by Pfahler and suc-

ceeded in getting these patients entirely well. This practical demonstration of the value of the highly filtered rays accompanied by high voltage so impressed me that I have never deviated from it since that time in treating malignant new growths.

It is interesting to note the letters I have received from different men throughout the country and with the exception of three none of them are using real deep therapy technique as I understand it. In fact, when I read a paper before this same society in November of 1918, several men came to me afterward telling me that I could get the same result by using a seven inch spark gap and a 3 millimeter filter. My only answer to that kind of an argument is that experience has not proven this to be true in my case. I have been using as a routine all of the voltage which the Coolidge tube would carry, never using less than 95 kilovolts and when possible going up closer to 110 than to 95. I have been using a parallel spark gap on my treatment transformer and during the entire treatment keep the spark just spitting across 9¾ inches of air space. I am living in a rather dry climate so I am getting more voltage with a 9¾ inch spark gap than one would get in a damp climate with the same spark gap, due to the fact that dry air has greater resistance to the passage of electricity than does moist air. Up to the present time I have been using a treatment machine equipped with a rheostat control. When one is using a treatment machine equipped with an auto transformer control, one can keep the voltage reading constantly at a certain point without using the parallel spark gap. Along with this high voltage I have been using 6 millimeters of aluminum and sole leather as filters. I have been using as a routine, 5 milliamperes of current at an 8 inch anode skin distance. Measure by Hampson's radiometer—using this technique it requires 5 minutes to give a pastille dose with the pastille resting on the skin underneath all of the filters. When I am treating malignant new growths I do not stop at the pastille dose but as a routine use three

times the pastille dose or 75 milliampere minutes with the technique described above. In extensive diseases where there is considerable vascularity and the condition points toward the fact that we should get as quick an action as possible, I even give as high as 225 milliampere minutes or 9 times the pastille dose over the same area. Of course I do not advise this extreme dosage without caution because this produces a burn. The reaction from it is tremendous but when the growth is located in the soft tissues near the surface, so that ulceration will do no harm, I employ it. I also employ this maximum dosage in the treatment of sarcoma. The burn produced by this treatment heals very quickly and looks and acts like the burn produced by radium. Practically speaking, I think this technique and dosage has the same clinical effect as radium treatment. I have a statement from Hirsch of New York who is using only a 4 millimeter filter and a 9 inch parallel spark gap at sea level. He claims that by measuring the amount of rays passing through 4 millimeters of aluminum by means of a Christen meter he finds there is little advantage gained by the additional 2 millimeters of aluminum. Arthur F. Holding did considerable experimental work during the years 1912–17, relative to the value of different thickness of filters, using the photographic effects of the ray upon sensitive plates. His report shows little difference in the photographic effects of the ray when passed through 4 millimeters of aluminum or when passed through 6 millimeters of aluminum. Even though this test on the photographic plate shows little difference when 4 or 6 millimeters of aluminum filter is used in my hands, as well as in the hands of Pfahler, Boggs and Ballard, the clinical effect on the patient is considerably different. There is more caustic action on the skin with the same dosage using 4 millimeters filter than when using 5 millimeters filter. The growth does not seem to melt down as fast under the thinner filter as under the thicker filter and high voltage. The skin recovers more quickly when the heavy filter and high voltage are used

than when the thin filter is used. Of course the better effects may be due to the high voltage used rather than to the amount of filter employed. I am convinced that both elements together with the massive dosage are responsible for my results.

I append herewith two case reports, one of a patient sufferly from hopelessly inoperable sarcoma and the other of a patient suffering from hopelessly inoperable carcinoma. In both of these patients the high voltage, 100–105 kilo-volts, and 6 millimeters of aluminum and sole leather filters were used. The results are no less than marvelous. The dosage is given in each case.

In conclusion, it would seem that a standard technique could be adopted for deep therapy. The author favors 100–105 kilo-volts, together with 6 millimeters of aluminum and sole leather filter working at an 8 inch anode skin distance. This technique combined with massive dosage in experienced hands will result in the maximum good from deep *x*-ray therapy in malignant growths.

Mr. D. C. C., 56, married, farmer. January 1, 1918, his throat began to get sore with difficulty in swallowing. In May a local physician sent him to Denver for diagnosis when Dr. E. C. Hill examined a section and found it to be small round cell sarcoma. Later Dr. Bevan recommended ligation of the carotid artery and radium therapy.

Examination—July 19, 1918. Patient swallows liquids with difficulty, can only speak in a whisper. The entire pharynx is filled with a growth, smooth in character and apparently arising from the right tonsil. The right sub-maxillary and cervical glands are enlarged to the size of the patient's fist.

Treatment—105 kilo-volts, 6 millimeters of aluminum and sole leather, 8 inch anode skin distance, 200 milliampere minutes over each side of neck and down over the mediastinum. He had a second series of treatments, one month later, using the same setting, giving 175 milliampere minutes. Two months later he had a third series with the same setting, using 150 milliampere minutes.

Results: The third morning after having had only two days' treatment, he walked into the office very happy because he had been able to eat a breakfast of griddle cakes, swallowing them without difficulty. A recent examination showed no evidence of the growth or of metastasis. He is in good health nineteen months after treatment.

Mrs. F. H., 44 years old, weight 90 pounds. Four years ago she noticed a lump in the right breast. July, 1915, she consulted a doctor who found trouble in both breasts. In 1915 she visited the Mayo Clinic when they found cancer of the uterus, liver and both breasts. She was referred for roentgen therapy, coming December 13, 1915.

Technique—105 kilo-volts, 6 millimeters of aluminum and sole leather, 8 inch anode skin distance. A total of 1050 milliampere minutes divided into fourteen series.

Results: She has had eighty-seven treatments, comprising fourteen series, covering the entire torso from the chin to the pubes—front, back and both sides. When she came she was bedfast and unable to eat or sleep because of the pain. Her pain disappeared, the uterine hemorrhage ceased, she gained weight, was able to sleep and eat anything she liked. She has been doing her own housework for more than four years. Both breasts are soft and the liver is barely palpable, while the uterus is freely movable and normal size.

Fig. 1. Front view photograph of patient suffering from extensive sarcoma of right maxillary sinus which had ruptured through the outer wall and was crowding the eye.

FIG. II. Oblique view of patient shown in Fig. I. showing the size of the growth on the outer surface of the cheek. The growth filled the entire right antrum, the right nares and protruded into the naso-pharynx.

FIG. III. Same patient after treatment was completed. This patient was treated with the following technique: 105 kilo-volts, 6 millimeters of aluminum and sole leather filter, 8 inch anode skin distance, 200 milliampere minutes over each area at the first seance. 125 milliampere minutes the second seance and 75 milliampere minutes at each of two more seances.

ABSORPTION AND SCATTERING OF X-RAYS

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The absorption of x-rays in their passage through matter is closely analogous, both qualitatively and quantitatively, to that of light.

Qualitatively, the absorption in both cases consists of two parts, which are usually called "true absorption" and "scattering". True absorption is a transformation of the x-rays or light into heat and chemical energy. Scattering is simply a change of direction of the x-rays or light. Examples of scattering in the case of light are reflection, refraction, and diffuse scattering by rough or milky substances. In the case of x-rays the scattering is generally diffuse, but crystals will reflect x-rays very perfectly if placed at the proper angle. Refraction of x-rays has not yet been observed.

Quantitatively, the absorption of x-rays is much simpler than that of light. The absorption of a given substance for x-rays is the same whether it be solid, liquid, or chemically combined with another substance, whereas the absorption of light depends almost entirely upon the physical and chemical state. The order of magnitude of absorption is about the same in the two cases. Organic solids and most metals are more transparent to x-rays than to light. Organic liquids, on the other hand, and most crystals and glasses, are more transparent to light than to x-rays.

The purpose of this article is to discuss (1) the mechanism of absorption of x-rays; (2) the magnitude of absorption, and the laws that govern it; (3) some simple applications.

THE MECHANISM OF ABSORPTION AND SCATTERING OF x-RAYS

True absorption of x-rays is due to the ionization by the rays, of the atoms of the absorbing substance. This ionization is of a special kind. It consists, like all ionization, in the loss by the atom of one of its electrons. But this electron is, in the first place, one of the most difficultly removable electrons in the atom, so that a large amount of energy is required to remove it; and, secondly, it is ejected with high velocity, comparable to that of some of the beta particles of radium. Hence, in addition to absorbing the energy of the primary x-rays, this ionization has two important results: (1) The ejected electron, or *corpuscular ray*, as it is sometimes called, plows through the atoms in its neighborhood, just like a beta particle of radium, ionizing every atom in its path. A single corpuscular ray produces several thousand ions before it is finally brought to rest. The number of atoms ionized directly by the rays is therefore a very small fraction of the total number ionized. Since chemical and physiological effects depend upon ionization, it is evident that the high speed *corpuscular rays* are the workmen who produce these effects. It is also to be anticipated that the physiological and chemical effects of x-rays and radium will be identical, except as regards distribution. (2) The second result of the initial ionization of an atom takes place when it "recombines", *i. e.* acquires an electron to fill the place of the one that was lost. This gives rise to *secondary* x-rays, sometimes called *Characteristic* x-rays, because their wave length is characteristic of the element that produces them, or *fluorescent* x-rays because, like fluorescence, their wave length is always longer than that of the rays that produced them. These secondary rays are absorbed in the same way as the primary rays, giving rise to more corpuscular rays and to *tertiary* x-rays of still longer wave length, and so on until all the energy is used up.

Scattering of x-rays is a much simpler phenomenon than

absorption. It is simply a re-radiation, in new directions, of the original rays. X-rays are electric waves. When they pass through atoms they set all the electrons in the atoms into oscillation, riding on the waves, so to speak. These oscillating electrons radiate a small fraction of the energy of their oscillation as scattered radiation. It is called *scattered* to indicate that it is identical in quality with the primary rays, but is radiated in all directions. It sometimes happens that a large fraction of the scattered rays reunite in some particular direction, causing regular reflection. This is the case with crystals, whose atoms are arranged in equidistant parallel planes. The reflection takes place only when the crystal is placed at exactly the right angle, and hence can be used to separate the *x*-ray wave lengths into a spectrum.

THE MAGNITUDE OF ABSORPTION AND SCATTERING

The absorbing power of a substance depends in a very simple way upon the kind of substance and the wave length of the rays. It is usually expressed in terms of an *absorption coefficient*,* which is the *rate of decrease of intensity of the rays per unit thickness of material traversed*, or the *mass absorption coefficient*, which is the absorption coefficient divided by the density.

In terms of the latter quantity the absorbing power of all substances for all wave lengths shorter than that of the characteristic K radiation of the substance, can be expressed, within the limits of accuracy of our present knowledge, by the following very simple law:

*The coefficient of absorption corresponds to the rate of compound interest, reckoned as a loss instead of gain. It may be called the rate of compound loss. If the loss were subtracted only after each centimeter traversed, the intensity I after traversing X cm. would be given by the compound interest law — $I = I_0 (1-\mu)^X$ where I_0 is the original intensity and μ the absorption coefficient or rate of loss per cm. When, as in actual absorption, the loss is subtracted after each infinitestimal thickness traversed, this expression becomes —

$$I = I_0 e^{-\mu X} \quad \text{(e = base of natural logarithms)}$$

This is the usual definition of absorption coefficient.

The mass absorption coefficient is proportional to the cube of the atomic number of the absorbing substance and the cube of the wave-length of the x-rays; or, in symbols:

$$\frac{\mu_0}{\rho} = .00556\ N^3\ \lambda^3\ ;\ \lambda < \lambda_k \qquad (1)$$

μ_0 is the true absorption coefficient in C. G. S. units.
P is the density of the absorber in grams per cc.
N is the atomic number of the absorbing element.
λ is the wave lengths of the *x*-rays in Angströms.
λ_k is the wave length of the limit of the K series of the element.

The scattering of *x*-rays obeys a still simpler law. It is practically the same for all substances and all wave lengths. Over the range of practical wave lengths it may be expressed with sufficient accuracy by the law:

The mass scattering coefficient is the same for all substances and all wave lengths. In c. g. s. units this constant value is 0.14.

$$\frac{S}{P} = .14 \qquad (2)$$

The total loss of energy in the *x*-ray beam per centimeter of absorbing material traversed is the sum of the true absorption and scattering. If we call this the *apparent absorption*, and denote its coefficient by μ, it will be expressed by the formula—

$$\frac{\mu}{P} = .00556\ N^3\lambda^3 + 0.14\ ;\ \lambda < \lambda_k \quad (3)$$

It is this *apparent* absorption which is usually observed, and is of greatest practical interest.

These relations are illustrated in the following figures and tables:

Figure *1* is a photograph of the *x*-ray spectrum of tungsten at 100,000 volts, showing the K series lines, α_1, β_1, at the left and the L series lines, a, b, c, etc., at the right, superimposed upon the general white radiation. The wave lengths are proportional to the distance measured from the

central line C. The limit of the K series of tungsten is just to the left of β_1, at $\lambda = .1785$ Angströms, and the limit of the K series of silver is shown by the absorption band Ag1, at $\lambda = .485$ Angströms.

Figure *2* shows a series of photographs of the K series lines of several elements. The limits of these series are just to the left of the line of shortest wave length in each case.

Table *1* gives the wave lengths in Angströms of the K series limits of all the elements for which this limit has been measured, and also the atomic numbers of the elements.

Figure *3* is a graphical representation of equation 3, showing the variation of total or apparent absorption with wave length for six different substances.

Figure *4* is the same series of curves as Fig. 3, plotted to a smaller scale, so as to show the values of $\frac{\mu}{\rho}$ for wave lengths greater than the limit of the K series, where equation 3 no longer applies. The equation similar to equation 3 applies to this range, but sufficient data is not available to determine the constants. The sudden drop in absorption at the wave length of the K series limit is responsible for the sharp bands in Figures 1 and 8.

Figure *5* is a test of Equation 3. Figure *5(a)* is a photograph taken with rays of wave length $\lambda = .211$ Angströms through equivalent thicknesses of six different materials, *i. e.*, such thicknesses as should give equal absorption according to equation 3. These thicknesses are:

Water	12.0 cm.	Molybdenum	.050 cm.
Aluminum ..	2.9 cm.	Silver	.034 cm.
Copper.....	0.158 cm.	Tin	.041 cm.

These thicknesses are just sufficient, according to equation 3, to absorb nine-tenths of the energy of rays of wave length .211 A. The equality of blackness of the six areas, in spite of the enormous difference in absorption coefficient, is proof that the equation is accurate enough for practical

purposes. Figure *5(b)* is a photograph taken with wave length $\lambda = .712$ A, through thicknesses just one-seventh as great as those in Figure 5(a). If equation 3 held for this wave length these areas should also be of equal blackness. This is true of water, aluminum, and copper. For molybdenum, silver, and tin, however, the wave length .712 is greater than the limit of the K series, as is evident from Figure 4 or Table 1, so that Eq. 3 does not apply. The absorption coefficients are much smaller than would be given by equation 3, hence the greater blackening.

APPLICATIONS

Three simple applications of the principles discussed above may be of interest:

1. *Production of Monochromatic X-rays.* The sudden jump of about seven fold in the absorption coefficient at the wave length of the K series limit makes it possible to cut off very completely the wave lengths just shorter than this without greatly affecting those just longer. This gives a sharp band as in Figure 8. On the long wave length side the limitation is not so sharp, but the fact that the absorption increases as the cube of the wave length makes the intensity fall off to an inappreciative value in a very short range of wave lengths, leaving nearly monochromatic rays. If, in addition, the range of wave lengths that is left includes one of the intense lines in the spectrum, such as α_1, in Figure 1, the monochromatic rays thus produced may be of sufficient intensity for many practical purposes. Figure 6 shows the spectrum of tungsten filtered in this way to give monochromatic rays of wave length $\lambda = .211$ A. The upper part of the photograph is the unfiltered spectrum; the lower part has passed through a filter of Ytterbium. Figure 7 shows the spectrum of molybdenum before and after filtering with zirconium. The filter has cut off very completely the rays of wave length just shorter than .687 A, and has reduced the line $\lambda = .638$ A from an initial intensity of 39 to less than 0.3, while reducing the line

λ = .712 from 62 to 10. This is the monochromatic source used in taking the photographs shown in Figures 8 and 9, and this and the monochromatic line .211 shown in Figure 6 were used in taking the photographs shown in Figure 5.

2. *X-ray Chemical Analysis—Absorption Method*—The sharp absorption bands produced by the sudden jump in the absorption coefficient at the wave length of the K series limit can be utilized for identifying an unknown substance. The substance to be tested is placed, as an absorbing filter, between the *x*-ray tube and the crystal which separates the wave lengths into a spectrum. The spectrum will then show a pronounced band, and a comparison of the wave lengths of this band with the values in Table 1 tells what the unknown substance is. Figure 8 shows a spectrum photographed in this way. The upper portion is the unfiltered spectrum the middle portion that of the rays which had passed through a molybdenum filter; and the lower portion that of rays filtered by an unknown substance, which was suspected of being a compound of molybdenum. It is evident that the unknown substance contained no trace of molybdenum. Further tests, by the method described below, showed it to be potassium sulphate.

3. *X-ray Chemical Analysis—Powder Pattern Method*—This method utilizes the scattering of *x*-rays. When monochromatic *x*-rays fall on a crystalline powder they are scattered only in certain definite directions, determined by the crystalline structure of the powder. A photographic plate placed in the path of the rays will show, in addition to the direct beam, a series of circles, whose diameters and relative blackness are characteristic for each particular powder, and can be used to identify it. Figure 9 is a photograph taken in this manner through aluminum powder. Figure 10 shows sections of a series of photographs of different powders, showing how extremely different the patterns are. All crystalline powders give patterns of this kind, and no two of the patterns obtained thus far are alike. Hence these patterns offer a simple and infallible method of identification of any crystalline material.

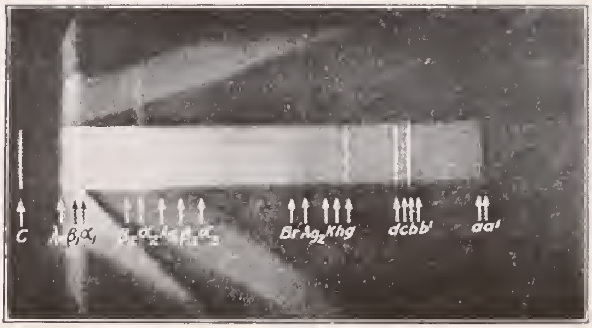


FIGURE 1
X-Ray Spectrum of Tungsten at 100,000 Volts

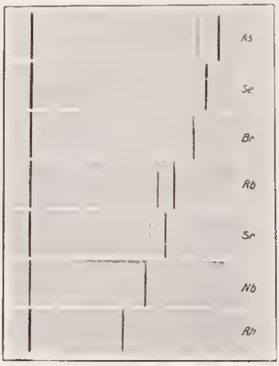


FIGURE 2
X-Ray Spectra Showing K Series Lines

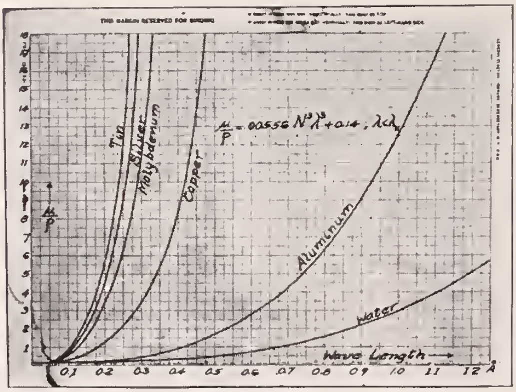


FIGURE 3
Variation of Absorption with Wave-Length

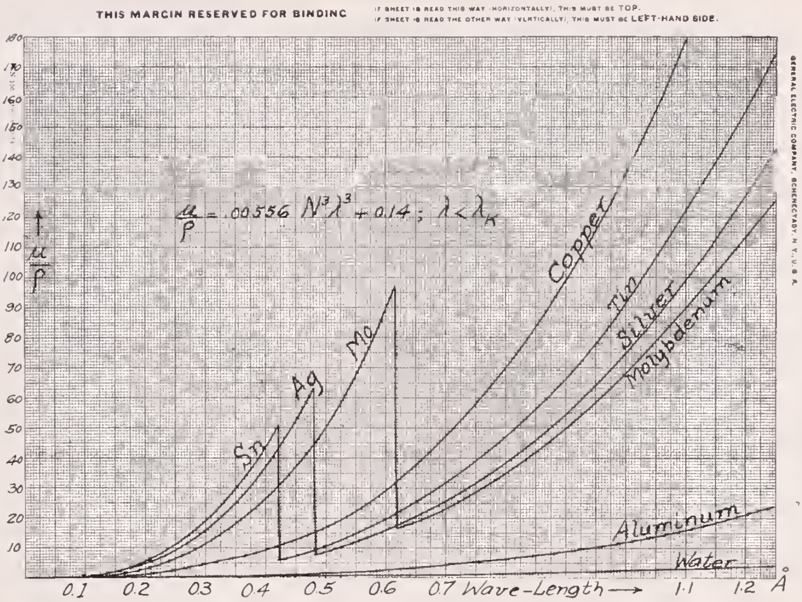


FIGURE 4

Variation of Absorption with Wave-Length

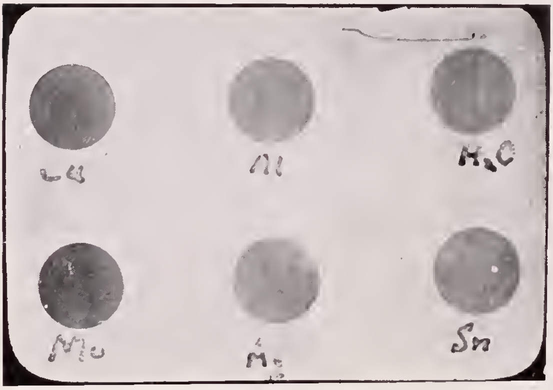
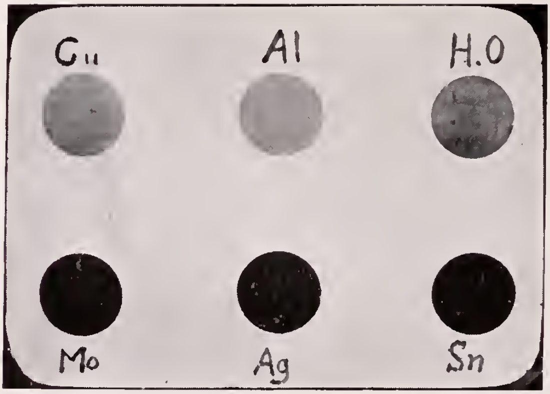


FIGURE 5

Test of Absorption Law Absorption of Equivalent Thicknesses

a

$\lambda = .211$ Angströms



b

$\lambda = .712$ Angströms

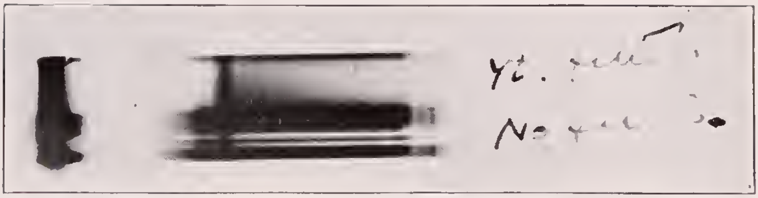


FIGURE 6

Monochromatic X-Rays. $\lambda = .211$ Angströms

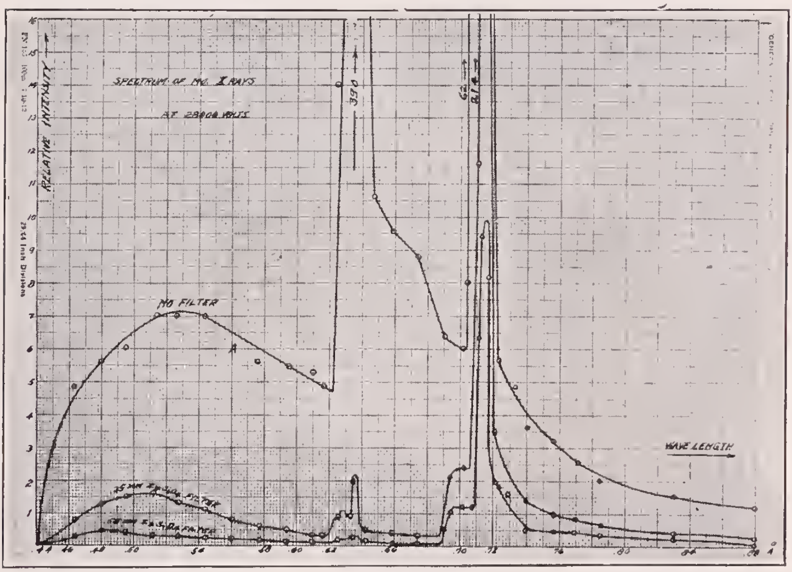


FIGURE 7

Monochromatic X-Rays. $\lambda = .712$ Angströms

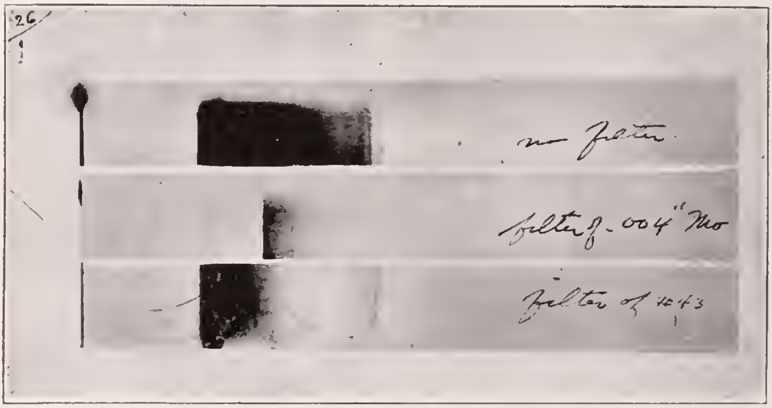


FIGURE 8
Chemical Analysis by X-Ray Absorption

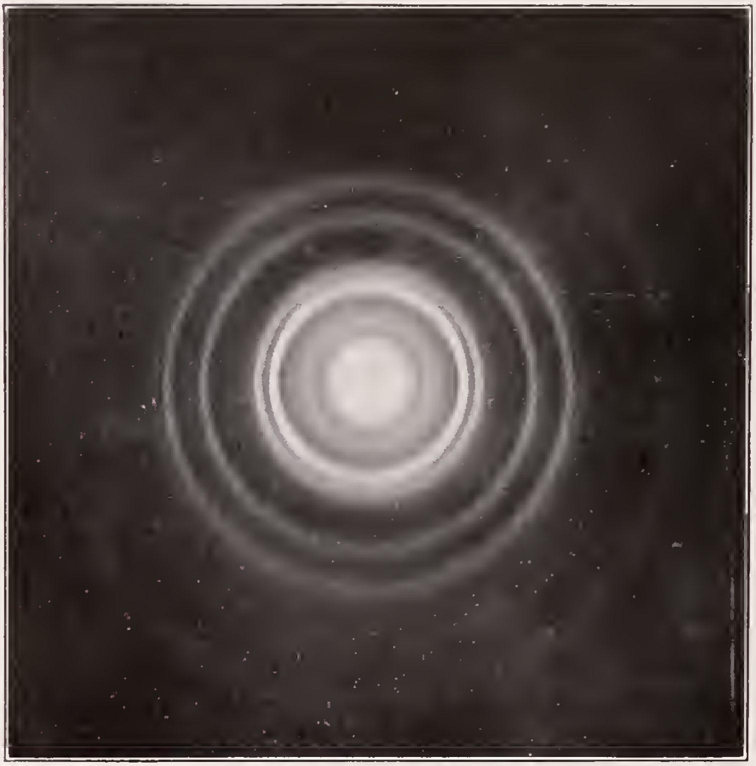


FIGURE 9
X-Ray Powder Pattern of Aluminum

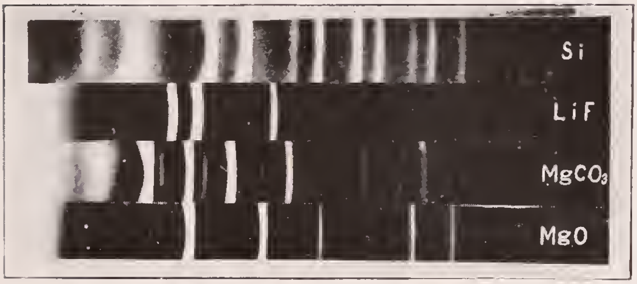


Figure 10

Typical X-Ray Powder Patterns

LOCALIZATION OF FOREIGN BODIES IN THE EYE

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In presenting this subject I will not attempt to bring out anything new or startling, but to go over the different methods that we may become more familiar with the technique of each and decide for ourselves which we believe to be the most accurate and least liable to permit of error.

Naturally, the first efforts to locate foreign bodies in the eye by the *x*-ray were rather crude, compared to the elaborate apparatus of today. It consisted simply of a lead ring made of heavy fuse wire and divided into quadrants by cross-pieces of smaller fuse wire. This ring was then fitted over the injured eye as high under the orbital ridge as it could be pushed, the crossed wires touching the closed lids. In size the ring was slightly larger than the eye-ball. The ring was held in place with a pledget of cotton and a strip of adhesive plaster. Two exposures were then made, one directly anteroposterior with the nose and forehead touching the plate, and one lateral. This showed in what quadrant of the eye-ball the foreign body is located and its apparent depth.

We will next take up the method of use of the Sweet Bowen localizer. This consists of two parts: the table and head rest, and the localizer proper. The table is so made that it carries a sliding plate holder that slips into a tunnel just under the top board. The top is covered partly with metal so that only half of the plate is exposed at one time; the unexposed half being covered during the first exposure and the exposed half covered during the second exposure. The table is also provided with clamps for holding the head perfectly still. This table is just four inches in height, so that it really takes the place of a pillow, and holds the head

level with the rest of the body when the patient is lying on his side. The plate carrier is so marked as to show just where to place the plate for each exposure.

It is assumed that before the use of any localization method you have first made and developed a single lateral plate to determine positively the presence of a foreign body.

The localizer is a small instrument on a heavy base or standard, with an upright arm for adjusting the localizer points up or down. The two points, one of which is tipped with a ball and the other a cone, are a known distance apart (15 mm.). Along the top of the localizer are sights similar to those on a rifle for centering the ball to the center of the pupil of the eye. The other end of the localizer is a sliding arm in a sleeve held with a spring and a trigger. This arm is now pushed forward until the trigger engages and the whole apparatus sighted to the center of the pupil, being careful to preserve as nearly as possible the axis of the eye. The eye is closed and the ball of the localizer pushed against the lid over the center of the pupil and the trigger pressed. This lets the whole arm of the localizer jump back so that the ball is just 10 mm. from the cornea of the eye. This 10 mm. must be taken into consideration when drawing the chart. The patient is now instructed to look steadily at a fixed object, preferably a lighted candle, some distance away and in a line with the localizer. This brings the axis of the eye in direct line with the localizer. The plate is now placed in the plate carrier and introduced into the tunnel with the first half ready for exposure. The tube is centered directly above the eyes of the patient and perpendicular so that in the first exposure the localizer ball and cone will coincide and will make only one shadow on the plate. After this exposure is made the tube is moved toward the feet of the patient some six to ten inches and tilted so as to direct the rays through the eyes. The unexposed half of the plate is put in position and the second exposure is made. The plate is now ready for development.

My procedure here is to let the patient get up and then

proceed to make another localization, going through identically the same process as in the first one. Both plates are then developed and if the measurements on the two plates differ more than one mm., both are discarded and two new ones made. This seems to me to be the only accurate way to check up this work.

As soon as the plates are dry we are ready to proceed with the drawing of the chart. These charts are obtained from the makers of the instrument and are printed accurately. Each little square is just one mm. in size and larger squares 10 mm. in size. The use of a mm. rule is necessary and a small pair of dividers are a help, but not indispensable.

On the half of the plate exposed first a line is now drawn through the horizontal axis of the ball and cone which are superimposed and at right angles to this a line is drawn through the foreign body. As an aid to measurement a line is drawn through the foreign body parallel with the line through the ball and cone, and just touching the ball and cone, remembering to deduct 10 mm. from this measurement, as both ball and cone were jumped back just this distance when the trigger was pressed.

Now going to the second exposure in which the ball and cone are separated we draw a line through the longitudinal axis of the ball and another through the same axis of the cone; also a line through the foreign body at right angles to these two lines. A line is also drawn at right angles to the axis of the ball and cone and just touching them. Still remember to subtract 10 mm. from the distance between line through the foreign body and the line touching the ball and cone.

We are now ready to begin making our actual measurements. The dividers are very convenient for this, but not actually necessary, as the plate can be held to the light and the mm. rule can be applied directly to the plate. We first measure the distance of the foreign body above or below a line drawn through the axis of the localizer and draw a line

on the chart across the front view of the eye-ball just this distance above or below center. This measurement is taken from the first exposure. We next take the second exposure and measure the distance above or below the ball and place a dot on the chart in the mid-line corresponding to this measurement. We do the same with the cone and put a dot in the dotted line just 15 mm. from the ball line as placed on the chart for this purpose. These two dots are now connected by a line drawn through them. Where the first and second lines cross is the location of the foreign body in the front view. We now draw a line upward through this crossing point, following the mm. lines on the chart and through the horizontal view, and then measure on the first exposure the depth of the foreign body, not forgetting to deduct the 10 mm. and draw a line at right angles to the line extending through the horizontal view. For the side view measure the distance above or below the center of the cornea, as in the first view, and draw in the side view and the depth of the horizontal view and draw at right angles to the first line in the side view and where the lines cross is the location of the foreign body in the side view. All that is left to do now is to count the little squares and set down so many mm. above or below the center of the cornea and so many to either the nasal or temporal side and so many deep. If your technique is perfect the result will be perfect. The greatest difficulty in all methods of localization of foreign bodies in the eye is to keep the patient looking steadily at a given object so as not to rotate the eye-ball. As these cases most often occur among uneducated foreigners, it is often hard to make them understand this and do as you tell them.

The latest method devised for this work is the improved Sweet's eye localizer. This is at first sight a complicated piece of apparatus, but when understood can be handled very readily. The first requirement is to have the tube accurately centered in the bowl. This is very important, for the reason that if it is not accurately centered the indi-

cator shadows on the plate will not coincide with the indicator spots on the key plate and thus give you a false reading.

The instrument consists of a movable head rest and clamps, and arm that lifts up and allows the placing of the patient in position and also carries the sighting attachment and the plate. Also a tube holder and carrier, which allows the tube to be slid along a track. There are small wheels for adjusting the sighting attachment and the head rest. Wheel A raises and lowers the whole tube carriage and arm; B tightens the head clamps; C adjusts head rest laterally, and D adjusts it longitudinally. Please pay especial attention to the little ring marked "E", as this is the indicator that appears on the plate and is also a part of the sighting apparatus. This will be referred to frequently as the indicator. The rest of the sighting apparatus consists of a mirror with a hole in it that is directly above the indicator. Also what is called a telescope, but in reality is an inverted periscope. This contains in its lower end a mirror set at an angle of 45 degrees, and a cross wire. There is also a flashlight that throws a small amount of light through a hole directly on the eye. The shutters for protecting the unused part of the plate are also carried on the arm.

The whole instrument is placed on the end of the *x*-ray table and the arm of the localizer raised and the patient on his back and his head in the head clamps with the injured eye farthest away from the tube. Sighting down through the hole in the mirror and the hole in the indicator the wheels are manipulated until the indicator exactly centers over the pupil of the eye. Now sighting through the inverted periscope the carriage is raised or lowered until the cross wire appears to be exactly over and touching the cornea. Your indicator is now exactly 10 mm. from the cornea. The shutters are now separated so that only the center of the plate is exposed. A five by seven plate is placed in the clips and the tube slipped in the center notch

and the first exposure made. Before making a second exposure it is always best to look through the periscope to make sure the patient has not moved. Patient is instructed to look constantly at the hole in the mirror. The principle of the sighting apparatus is best explained by the following drawing. The tube is now shifted on its track as far as it will go toward the feet of the patient and the shutter farthest from the feet of the patient is shifted toward the feet to cover the exposed center of the plate and the second exposure made. I always go through the entire procedure a second time and both plates must check up within one mm. or both are discarded. It is always best to ground the instrument to prevent static sparks to the patient.

After the plate is developed, both exposures will look like this. Notice the shadows of the indicator in the upper part of the plate. These indicators should exactly coincide with the rings and dots on the key plate and will do so if the tube has been exactly centered in the bowl. The way the key plate is constructed you are supposed to have the *x*-ray plate dry before taking the measurements. The time of washing and drying can be saved by reversing the key plate and putting the glass side of the *x*-ray plate to the reversed side of the key plate. The readings are exactly the same except that the letters are backward and left should read right, and *vice versa*. It is now only necessary to set down three readings: one each for above or below center, one for nasal or temporal side, and one for depth. On the chart that is already printed, the exact angle at which the second exposure is made is preserved. The little squares in the key plate are laid off in two mm. size and the large square are in 10 mm. In the key plate A and B determine whether above or below the center of the cornea, and C and D whether to the temporal or nasal, and E the depth. It is not necessary to make any measurement with this method, as that is taken care of by the key plate.

For illustration, we will say that our figures taken by putting the *x*-ray plate against the key plate are B 2, D 2,

and E 14, drawing a line along B 2, through the front view of the eye and also a line through D 2, till they cross, will give the location of the foreign body in the front view. A line is drawn through this crossing point and through the horizontal view. A line is now drawn along E 14, until it crosses the line in the horizontal view. From the first view and the horizontal view it is an easy matter to draw the side view. The reading would now be 2 mm. below center, 6mm to nasal side, and 10 mm. deep. By not having to wait for the washing and drying of the plate this is the most rapid method with which I am acquainted. Also it is the most accurate.

Doctor Titterington: As far as the indicator points becoming bent is concerned, I always measure them before I use them to see they are just fifteen millimeters apart. I have never checked up both methods on the same case. I have often thought I would, but have simply neglected to do so. One great source of error is the rotation of the eye. That is the hardest part of the whole thing—to get the patient to look steadily at one given object, because if a patient is looking at one object in one exposure and at another object in the second exposure, you are likely to get them clear in front of the eye or clear out to one side. As I tried to bring out in the paper, that the most important thing is to insist, absolutely, that they look at one given point, and do it all the time. Do not have them look just when you are giving the exposure. Tell them to look all the time.

Doctor Titterington: Nothing more.

Doctor Briggs: The Doctor has brought out a number of times in the paper the importance of that ten millimeter allowance for the shift of the indicator shaft. I had a case some time ago where, using the first method he has described, we found the localization approximately a millimeter anteriorally, or in front of the anterior margin of the cornea. On a shift examination it was possibly a half millimeter in front. On making an examination of the eye I

found a small piece of shell imbedded in the conjunctiva, with a small film of conjunctiva lying over the foreign body, so the foreign body practically was outside the eye, although anatomically it was not.

About 1917 I had my attention called to a case where one of the laboratories had attempted to localize a foreign body by means of the first method of which he spoke. The chart was brought to the office and the foreign body localized about five millimeters in front of the eye, out in space. (Laughter.) I would like to ask the doctor if he has ever made any tests of the two methods on the same case; that is, using the old Sweet localizer and checking it up with the new Sweet localizer, to see which is the more accurate of the two, or if there is any difference?

Doctor Ernst: I would like to add a word of caution with reference to the first method described, regarding the ball and cone points on the Kelley-Koett Localizer. It would be well to measure these points previous to each examination. On two occasions I found no less than three-fourths of a millimeter difference; more than the 15 millimeter correct separation. That, of course, is sufficient to give us an incorrect localization.

212 Metropolitan Bldg.

FIG. 1. Posterior-anterior view with nose and forehead touching the plate.

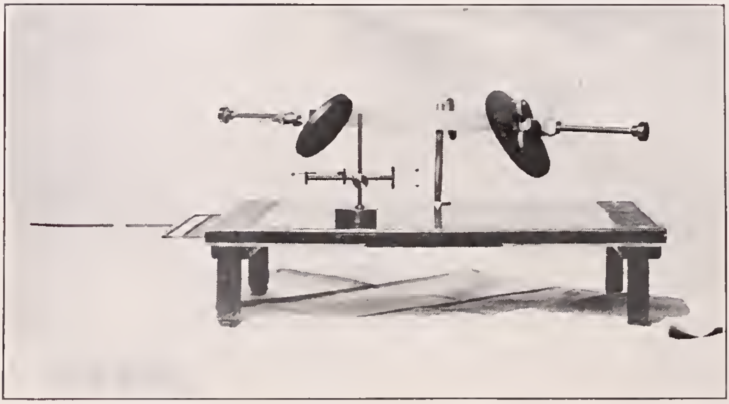

FIG. 2. This table carries a sliding plate holder that slips into a tunnel, just over the top board.

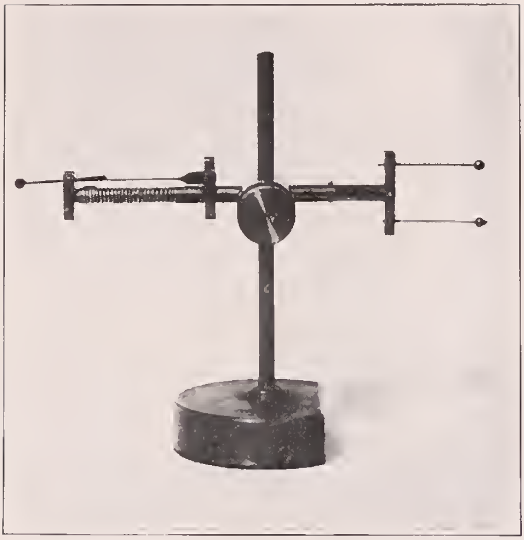

FIG. 3. The localizer showing an upright arm for adjusting the localizer points up or down.

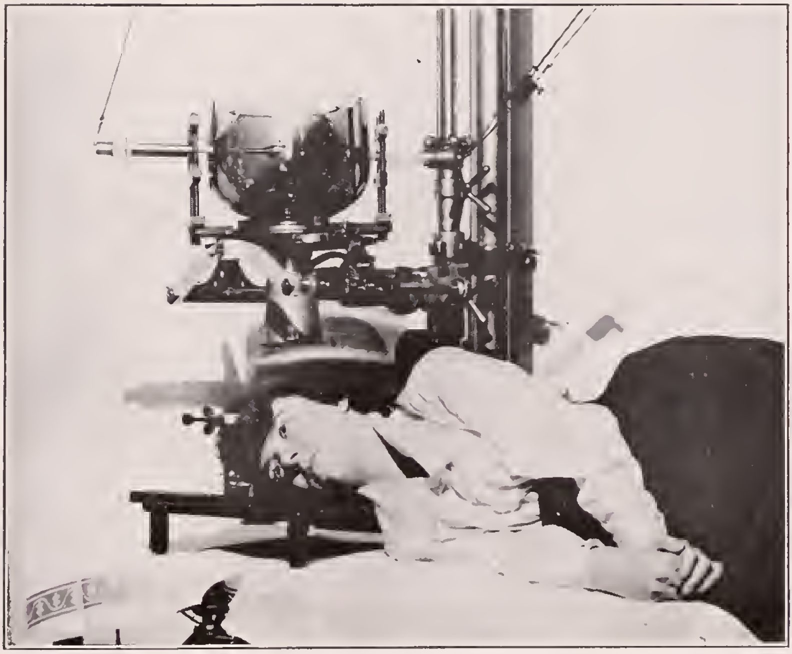

FIG. 4. Patient in position for the lateral exposure, which will show the localizer, ball and cone to coincide, and will make only one shadow on the plate.

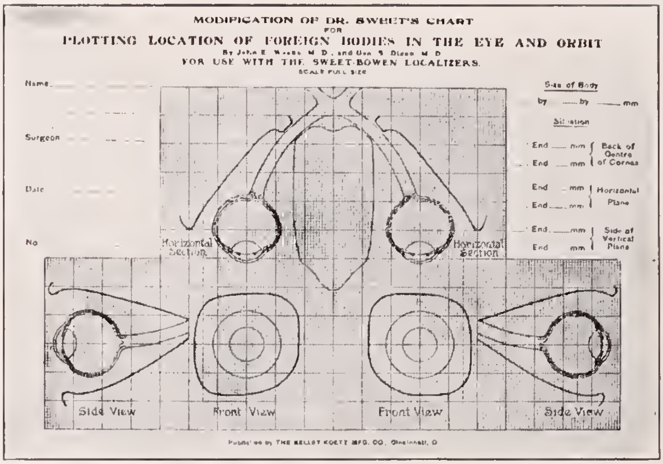

FIG. 5. Modification of Dr. Sweet's chart. The large squares are ten millimeters and the small ones one millimeter.

FIG. 6. Tube holder and headrest. Wheel A raises and lowers the tube. B, tightens the head clamp. V, adjusts the headrest laterally. D, adjusts the headrest longitudinally. E, sighting apparatus.

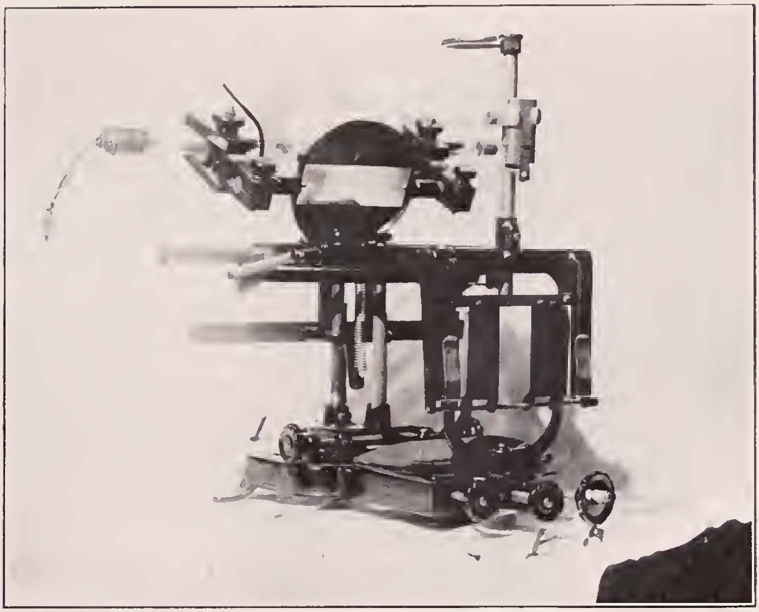

Fig. 7. The sighting apparatus, which is called a telescope, but in reality is an inverted periscope. This contains, in the lower end, a mirror, set at an angle of forty-five degrees, and a cross wire.

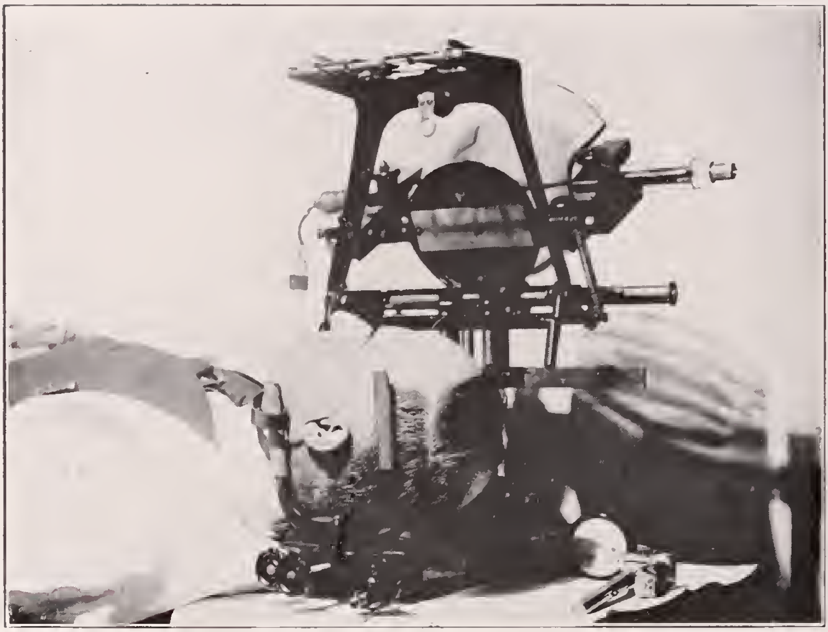

FIG. 8. Patient's head in position, with the injured eye farthest from the tube. Sighting down through the hole in the mirror and the hole in the indicator the instrument is manipulated until the indicator exactly centers over the pupil of the eye.

FIG. 9. Shutter closed to center over the eye.

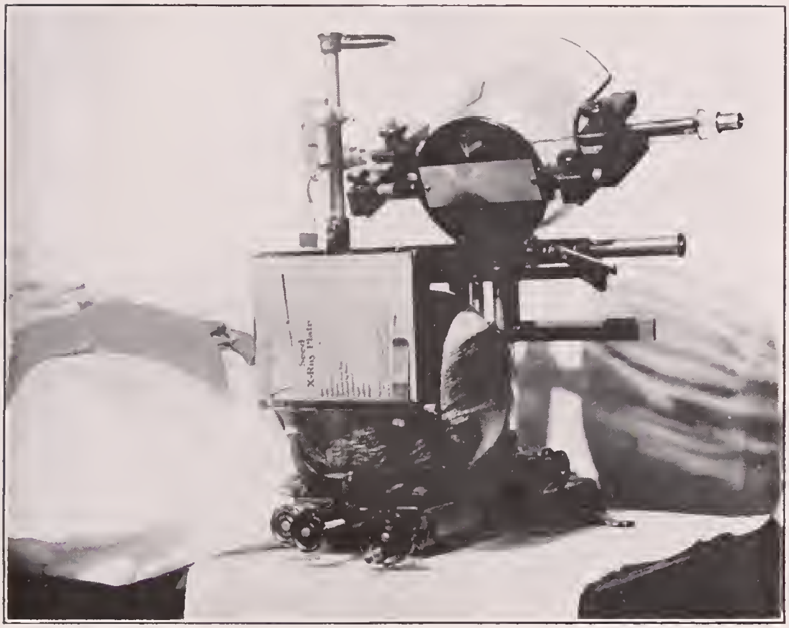

FIG. 10. Plate in position, ready for exposures.

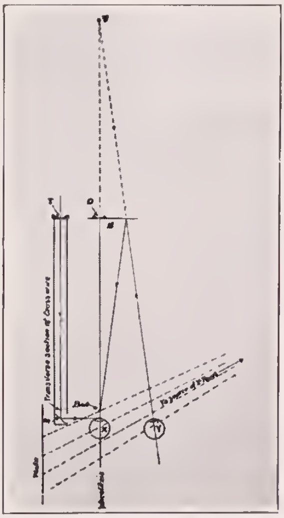

FIG. 11. The principles of the sighting apparatus.

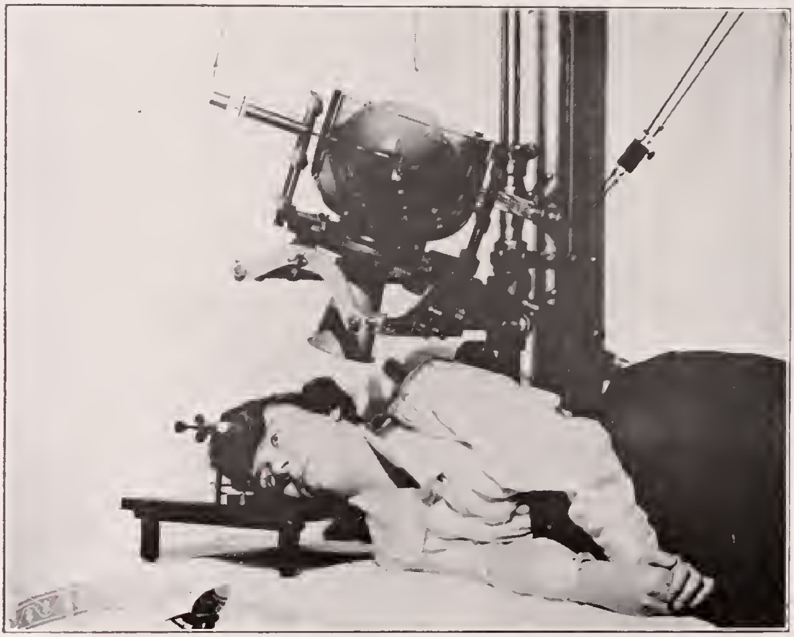

Fig. 12. Patient and tube shifted for second exposure.

Fig. 13. Plate showing the relation of the foreign body to cone and ball in both exposures.

FIG. 14. These indicators should exactly coincide with the rings and dots on the key plate, and will do so if the tube has been exactly centered in the bowl.

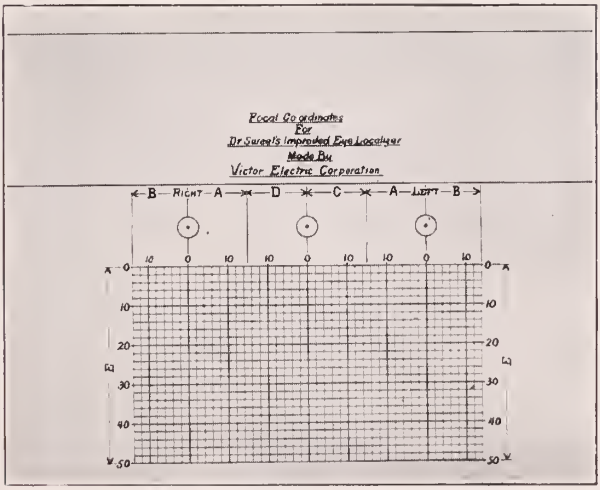

FIG. 15. Focal coördinates for Dr. Sweet's improved eye localizer.

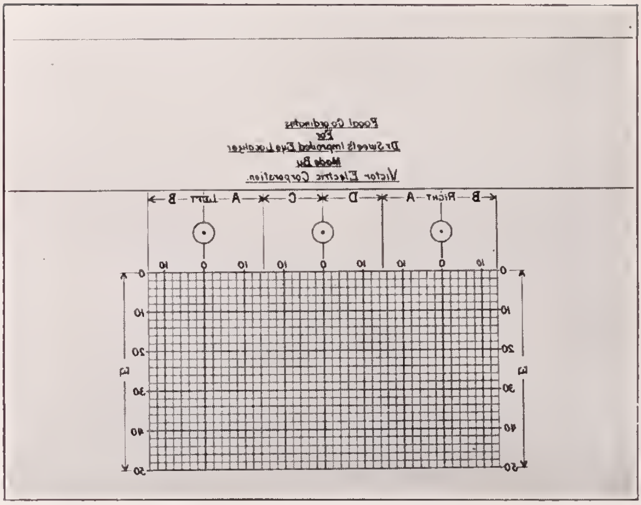

FIG. 16. Key plate reversed.

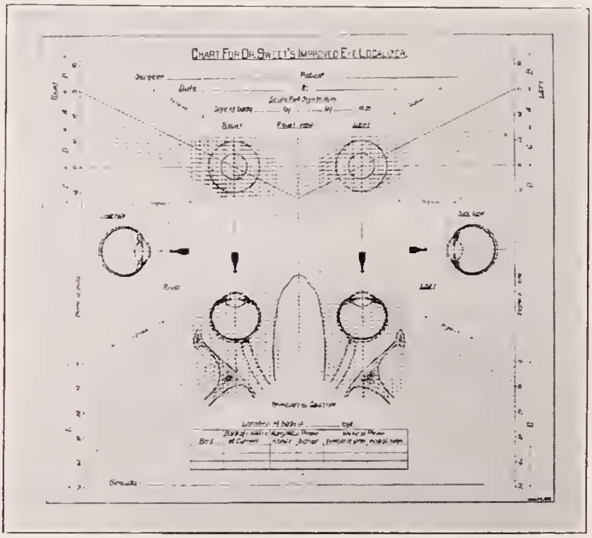

FIG. 17. Chart for Dr. Sweet's improved eye localizer.

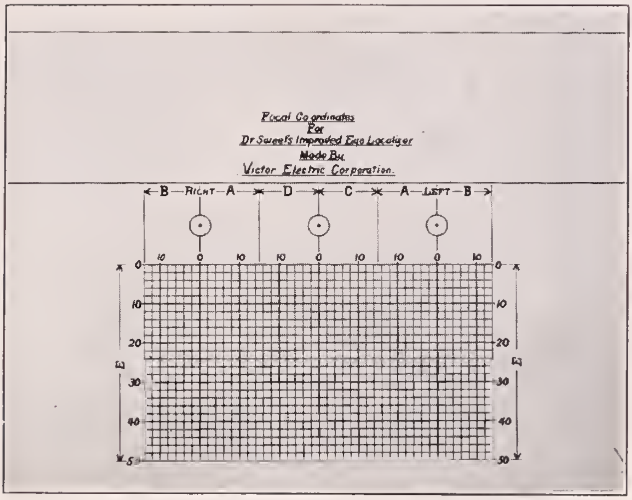

FIG. 18. In the key plate A and B determine whether above or below the center of the cornea, and C and D whether to the temporal or nasal and E the depth. It is not necessary to make any measurement with this method as that is all taken care of by the key plate.

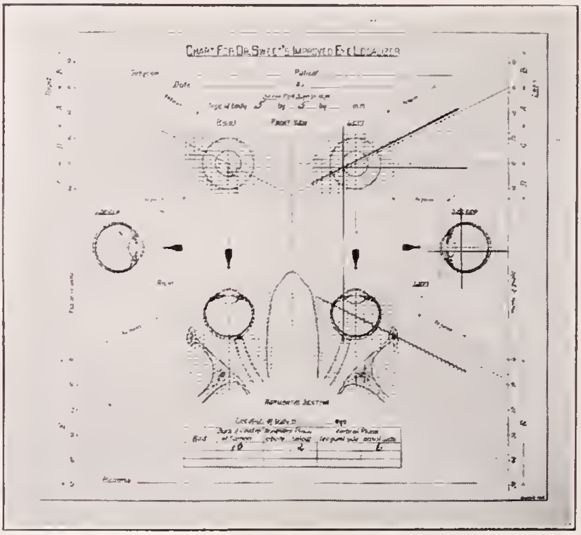

FIG. 19. For illustration we will say that our figures taken by putting the x-ray plate against the key plate are B 2, D 2, and E 14, drawing a line along B 2, through the front view of the eye and also a line through D 2, till they cross, will give the location of the foreign body in the front view. A line is drawn through this crossing point and through the horizontal view. A line is now drawn along E 14, until it crosses the line in the horizontal view. From the first view and the horizontal view it is an easy matter to draw the side view. Our reading would now be two millimeters below center, six millimeters to nasal side and ten millimeters deep.

CONGENITAL PYLORIC STENOSIS

Robt. A. Arens, M. D.
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In the discussion of congenital pyloric stenosis I shall endeavor to present a more accurate and concise method of diagnosis. This method has been used in over 100 cases with absolute exactness, the operative findings confirming a positive diagnosis in every instance. Not only is it my belief that the roentgen findings are almost infallible when a proper technic is used, but in a case of partial stenosis the roentgen ray should be the means of deciding upon an early and immediate operation, as the condition is usually a progressive one and the pathology is not so marked, giving the infant the best possible chance for recovery, inasmuch as its vitality is at its best.

The pathology found in this class of patients consists of a muscular hypertrophy of the pyloric sphincter. The etiological factor in this condition is a mooted question and I will not presume to discuss it here. The fact remains, however, that in a true stenosis there is always a tumor present in the sphincter. This tumor may be large or small and may involve the entire muscle or only a portion of it. A small hypertrophy of the entire muscle or a portion of it, may be sufficient to cause a complete pyloric stenosis, whereas even a large tumor might be so located in only a portion of the sphincter that it produces only a partial obstruction.

The difficulty of diagnosing the condition by clinical methods is not apparent at first glance. Quoting from a recent article: "The first symptom that attracts attention is vomiting, frequently beginning as a regurgitation which gradually becomes worse until it becomes distinctly projectile in character, the vomitus often being projected several feet.

It occurs after each feeding or after several retained feedings. There is nothing distinctive about the character of the vomitus. Of all the symptoms, the vomiting is the most alarming. A peristaltic wave appears after food is taken, and radiates from the cardia to the pylorus. A tumor may be felt to the right and above the level of the umbilicus, usually a small movable mass. There are scanty stools and urine and progressive loss of weight. It is now generally agreed that only in the mildest cases with partial retention and with no loss or little loss of weight should expectant treatment be tried. In all other cases, operation should be advised at once."

The question which here presents itself is, is this a pyloric stenosis or is it a case of pyloro-spasm? Is the etiological factor a pyloric hypertrophy, does it contain a neurotic element, or is it the result of a dietic error? It is here that the roentgen ray can with absolute accuracy make a differential diagnosis between these various conditions and so serve as an indication for the subsequent treatment.

Clinically these three conditions may show the same signs and symptoms. Visible abdominal peristalsis is usually accepted as an extremely valuable objective sign; coupled with projectile vomiting, loss of weight and inanition, the diagnosis of pyloric stenosis is usually made. Fluoroscopy has shown us the fallacy of these objective signs in this condition. Cases which have been diagnosed as congenital pyloric stenosis by the roentgen ray with confirmative operative findings, have shown us that this condition may exist with little visible abdominal peristalsis, although there may be a marked hyper-peristalsis of the stomach present. Again other cases which clinically appeared to be pyloric stenosis upon examination have shown conclusively that even with marked abdominal peristalsis, the pylorus opened and permitted readily the passage of the opaque meal. I am fully satisfied from our observations that visible gastric peristalsis may exist with or without stenosis, and that loss of weight may come on with or without stenosis. Clinically,

it is possible at times to palpate the tumor in the pylorus, yet this is a personal equation, in which out of a dozen men, one or two might be conscientiously able to say that the mass is palpable, the mass being however more readily palpable in the later stage. It is the early and accurate diagnosis in which we are chiefly concerned. The roentgen findings do not depend upon any of these signs but upon the functional condition of the pylorus itself.

Technic

It is essential that a careful technic be followed. Our routine consists in withdrawing the feeding prior to the first roentgen examination. This is essential for if a late feeding is permitted there are no means of ascertaining whether the fluid found in the stomach is a hyper-secretion, if such does occur, an abnormal retention, or the remains of the feeding which had been given within too short a time to be evacuated. In our early work the patient was given the opaque meal by means of a catheter. This was found to be extremely unsatisfactory, because even in normal patients the irritation of passing a catheter was sufficient to cause a regurgitation, which in many cases was difficult to distinguish from the stenotic type.

We now use the ordinary feeding bottle with a standard rubber nipple, the hole of which is usually too small to permit the passage of the opaque meal, so we simply cut it larger. The opaque meal consists, in accordance with the age of the child, of the proper amount of mother's milk, or if this is not obtainable, modified cow's milk will also be found satisfactory. Sufficient bismuth subcarbonate is added to this feeding so that the opacity of the media insures a good roentgen contrast.

The child is rotated on its abdomen, lying slightly on the right side so that the ingested media by gravity passes downward to the pylorus. This is an extremely important item as all of these patients swallow a large amount of air increasing the intragastic pressure and ballooning out the

stomach. In a physiological attempt to relieve this pressure, the child attempts to belch. Should the child be lying on its back or on the left side, the feeding is gathered in the cardia covering the cardiac orifice of the stomach. The gas is at the pylorus, mechanically rising to this area which, on account of the posture of the child, lies uppermost. With an effort to belch the cardiac sphincter relaxes and being covered by fluid, the feeding is projected out so that we have what in many cases is termed projectile vomiting. The gas remains in the stomach. When the child is lying on the right side and the gas consequently is in the cardia, the child belches nothing but gas.

A true case of stenosis presents a typical fluoroscopical picture, which has been described in an article by Dr. A. A. Strauss and read before the American Medical Association in June, 1918. In brief, a small quantity of bismuth passes through the pylorus which immediately closes down. Following this, there is a quick rhythmic, whip-lash, or snake-like movement which takes place in the antrum and pylorus. It is characteristic. This quick peculiar movement appears independent of the gastric peristalsis and is pathognomonic. The plates are then taken in that position which the fluoroscope reveals to be the one in which the points of interest can best be observed. Some cases reveal a retro-peristalsis of the stomach and in these cases there may be found a dilated oesophagus, but this associated condition is not always present.

Types

There are three distinct types of stomachs found in this condition. 1. The stomach is dilated and contains considerable fluid, a marked hyper-peristalsis usually appears with the peculiar snake-like lashing of the antrum as described before. The opaque meal in small quantities passes through the pylorus. The pyloric sphincter suddenly contracts, closing the pylorus and preventing the passage of the opaque meal. At the end of two hours a little more can be observed

to have passed into the small intestine, but the amount is very small and is scattered in small masses. At four hours there is a large retention in the stomach consisting of at least one-third of the ingested meal.

2. The opaque meal at no time is observed to pass through the pylorus. At the end of two hours and at four hours, there is a complete retention of the bismuth meal in the stomach. The stomach is more dilated than type No. 1 and there is a larger amount of fluid present. At first there is a marked hyper-peristalsis present again with the peculiar snake-like lashing of the antrum. This labor dies down and becomes very superficial. At four hours there may be no peristalsis at all, or in a number of cases retro-peristalsis was observed.

3. This type is not a well developed case of stenosis. It represents almost the normal infantile gastro-intestinal tract. The stomach is slightly dilated and the peristalsis is deep cutting, almost a hyper-peristalsis. The antrum and pars pylorica cut off well but with the lashing to and fro of the antrum. The pylorus and duodenum fills well and the bismuth mixture passes rapidly into the small intestines. At two hours the stomach is over half empty. At four hours the stomach is entirely empty but with a full four hour motility. The normal gastric motility varies from 2½ to 3½ hours.

With types one and two the indication is for immediate surgical interference. Type three should be placed on expectant treatment until either the pathology progresses sufficiently to place it in class one or two, or until it is determined that the pyloric condition has not advanced. In either event the *x*-ray should be used as a control. It should be noted that in this type, at four hours the stomach is empty. This does not hold true in all cases, for there may be a very slight retention at this time. A retention of one-third or over of the original meal we consider as an operative indication. It is interesting to note that twenty cases of partial stenosis were treated with good results medically.

Total number of infants examined: 132.

Total number of roentgen diagnoses positive: 85.

Total number of roentgen diagnoses negative: 47.

Total number patients operated: 65.

Total operative findings positive: 65.

Resume: The roentgen diagnosis of congenital pyloric stenosis consists of:

1. Dilated stomach.
2. Hyper-peristalsis.
3. Characteristic snake-like movement of antrum and the pylorus.
4. The pylorus may be partially or totally obstructed.
5. One-third or more retention of bismuth meal in four hours.

These patients while under examination should be placed on the right side so that the pylorus is down. This prevents regurgitation. Even a normal infant permitted to lie on the left side may show a retention. These patients were all taken from the clinics of Drs. Abt, Lackner, Hess, Jampolis, Michaels and A. A. Strauss of the Michael Reese Hospital who in every way possible contributed to the success of our roentgen conclusions.

THE JOURNAL OF RADIOLOGY

PUBLISHED EVERY MONTH AT IOWA CITY, IOWA

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Abstracts

W. S. Lemon, M. D. Differential Diagnosis of Mediastinal Tumors. *Medical Clinics of North America,* November, 1919, No. 3, p. 635.

Since roentgenology has come to aid the clinician so materially, the following classification of mediastinal affections is offered.

1. Anterior
   (a) Remains of the thymus, or the thymus itself
   (b) Lymph-nodes
   (c) Areolar tissue
2. Middle
   (a) Heart with its arterial and venous trunks
   (b) Trachea and bronchi
   (c) Hilus of lung on each side
3. Posterior
   (a) Lymph nodes
   (b) Esophagus
   (c) Thoracic duct
   (d) Vagus, phrenic and sympathetic nerves

A certain group of symptoms is common to diseases affecting the mediastinum. This is symptoms of pressure on its several structures.

The organs and lesions studied are:

1. Benign neoplasms
2. Malignant neoplasms
3. Abnormally placed organs
   (a) Substernal goiter
   (b) Thymus
4. Hodgkin's Disease
5. Lymphosarcoma
6. Tuberculosis

7. Pathological conditions in the circulatory system
    (a) Aortitis
    (b) Dilatation of aorta from pressure
    (c) Mitral stenosis
    (d) Cardiac hypertrophy, especially with aortic insufficiency
    (e) Pericarditis with effusion
8. Potts' Disease
9. Aneurysm of the thoracic aorta
10. Syphilitic mediastinitis

Benign Neoplasms

Very rare, and of little importance on that account. Dermoids, chondromata and actinomycosis are the types found.

Malignant Neoplasms

Usually single and distinct in outline on roentgen examination. Infiltrating, and grow outward into the chest.

Abnormally Placed Organs

1. Substernal goiter. Not difficult to determine. Roentgen examination reveals a well defined and continuous tumor with the extra-thoracic or cervical.

2. In children, the roentgen shadow of the thymus resembles that of the substernal goiter. It is central, continuous from above downward, and frequently is superimposed on the heart shadow. It is the most frequent mediastinal tumor in infancy.

Hodgkin's Disease

Differentiation not difficult. The clinical history is usually decisive, and the roentgen examination serves to confirm and determine the extent of involvement. The growth is bilateral, extending from the hilus. It is diffuse and feathery in appearance. Frequently fluid is present in the pleural cavity.

Lympho-Sarcoma

It is most common, and often confused with Hodgkin's disease. It is unilateral and distinctly circumscribed.

Metastasis may be present. If the tumor is near the aorta, pulsation may cause difficulties in examination.

Tuberculosis

Seldom difficult because of other evidence of the disease in the chest.

Aortitis

Fluoroscopic and roentgenographic examinations differentiate when clinical signs fail. The aorta is uniformly broadened.

Dilatation of Aorta

Roentgen signs are not given, but said to clear up the diaphragm.

Mitral Stenosis

Roentgen examination not mentioned.

Simple Cardiac Hypertrophy

Roentgen signs show a normal heart magnified. Shape is pearlike, and it fills the costophrenic angle and is uniform over auricular and ventricular areas.

Pericardial Effusion

The roentgen signs of a pyramidal shape of pericardial effusion are invaluable.

Potts' Disease

There will be a fusiform symmetrical shadow superimposed on the spine, with destruction of the vertebrae and a narrowing of the costal angles.

Aneurysm

It is the only tumor that erodes and penetrates the chest. A pulsating tumor directly in association with the circulatory mechanism.

Syphilis

Gummata: Large unilateral and well circumscribed, frequently in parenchyma. Decreases in size under treatment.

Mediastinitis

Diffuse substernal shadow, lessening on anti-syphilitic treatment.

Actinomycosis

Fimbricated halo, indicative of inflammatory conditions.

Dr. José Luis Carrera. A Pathological Study of the Lungs in One Hundred and Fifty-two Autopsy Cases of Syphilis. *The American Journal of Syphilis*, January, 1920, Vol. IV, p. 1.

Workers in Roentgen Interpretation should be interested in this original article of a Spanish research student in the laboratory of the University of Michigan, Ann Arbor.

The infrequency of syphilis in the lungs should be kept in mind by the enthusiast. A review of the literature brings out the following interesting information in twenty-one pathological considerations.

1. Frequency of Syphilis of the Lungs

Osler found twelve cases syphilitic lesions in the lungs out of 280 autopsies on syphilitics.

Peterson found eleven cases syphilitic lesions in the lungs out of 88 autopsies on syphilitics.

Stalper found 65 out of 2,995 autopsies on syphilitics.

Hunter, Ellers, and Wires one out of 1000 cases on syphilitics.

These give the lungs the last place in frequency. Clinical men give a much higher frequency and the tendency to make clinical diagnosis is increasing. The discovery depends on the intuition of the observer. The roentgen ray has given more assurance as to diagnosis.

Males have lung findings more frequently than females.

2. Types of Pulmonary Syphilis

Two types of lesions: Gumma and fibrosis. Writers differ in their conceptions. Our knowledge of lung syphilis is incomplete.

3. Spirochetes in Lung Tissue

The spirocheta pallida has been found in congenital syphilis by many workers. In acquired syphilis only a few workers have reported the spirochetes. Finding them in sputum is very questionable.

4. Inception of Pulmonary Syphilis

Writers are in general agreement that the early stages are unknown.

5. Gumma of the Lung

Most descriptions are of the gross appearance. Microscopic descriptions agree on three zones of central degeneration: Acaseation, an intermediate and an outer zone of infiltration.

6. Location of the Gumma

May be anywhere but seldom in the apex, and usually in the right.

7. Gumma in Congenital Syphilis of the Lungs

Described by many writers.

8. Diffuse Syphilitic Pneumonia

Virchow could not differentiate syphilitic pneumonia. Modern writers think they are not different from ordinary pneumonias.

9. Syphilitic Caseous Pneumonia

Most writers deny its existence.

10. Lymphangitis Syphilitica

Of indefinite status.

11. Muscle Cirrhosis—Brown Induration

The so-called carnification of the liver falls in this class. Most writers find that brown induration occurs in syphilitics.

12. Chronic Interstitial Pneumonia—Sclerosis

Syphilis is a disease of chronic evolution and inflammatory reaction with a tendency to the formation of connective tissue. This observation is marked in the lungs and

occurs as an interstitial pneumonia often marking out the lobulated areas.

13. Syphilitic Phthisis

The pathology consists of peri-bronchial fibrosis, empyema, fibroid bands, bronchial dilatation and formation of cavities opening into the bronchi.

14. Bronchial Lesions

Bronchial thickening and bronchiectasis have been noticed by many.

15. Alveolar Epithelium

The alveolar epithelium often appears cuboidal or even low columnar, gland like, but it is not necessarily syphilitic.

16. Syphilitic Lesions in Pulmonary Arteries

The process is mesarteritis and periarteritis as in syphilitic aortitis.

17. Lesions of the Pleura

While pleuritis is observed it is not characteristically syphilitic.

18. Anthracosis and Syphilis of the Lung

Anthracosis seems more frequent and pronounced.

19. Elastic Tissue in Pulmonary Syphilis

Especially in vessel walls has this condition been noted.

20. Syphilis and Tuberculosis

Many cases have been classed tuberculous are syphilitic. Hertz, Virchow and others disagree on the possibility of differentiating the gumma and tubercle. The gumma is considered rich in vascular formation. Groups in masses, scarce in giant cells, infrequent in calcification, preserves the pulmonary tissue.

21. Giant Cells in Syphilis

They occur in both tuberculosis and syphilis, but in tuberculosis are more abundant. There is no difference in the cells in either condition.

II. Results of the Study of the Lungs in 152 Cases of Syphilis, Pathological Laboratory, University of Michigan.

Aside from the relative infrequency of pulmonary gumma little is known of the pathology of syphilis of the lungs.

In twelve cases out of one hundred fifty-two were pathological changes in the lungs undoubtedly syphilitic, as follows:

1.	Gumma of the Lungs....................	3	Cases
2.	Syphilitic Peribronchitis with Arteritis..	2	"
3.	Syphilitic Fibrosis with Arteritis........	4	"
4.	Syphilitic Arteritis	3	"
		12	

One of the cases presented gumma in the lung which could be diagnosed macroscopically. It was confirmed by the microscope. The other two cases were diagnosed by the microscope.

Fibrosis is the end of a syphilitic process, but to be positive that syphilis caused the lesion it was necessary to prove it. The typical inflammatory process must accompany it in order to prove the nature.

Eighteen cases showed fibrosis, four were proven to be syphilitic.

Syphilitic lesions of the vessels are typical when found, and may be differentiated from tuberculosis. Tuberculosis takes all the coats of the vessels en masse. Syphilis, one or two.

The coincidence of brown atrophy. the typical heart lung (passive congestion in 100 cases out of 152) illustrates the importance of syphilis as an etiologic factor in cardiac disease.

While pleuritic changes were found they were in no way peculiar to syphilis.

Typical active syphilitic peribronchitis was found in two cases.

A terminal broncho pneumonia or croupous pneumonia occurred in a very high per cent of the cases in connection with an inadequate heart.

Conclusions

The diagnosis of pulmonary syphilis must be made microscopically. The lungs show an incidence of fibrosis comparable to that in other organs in the same cases.

Pulmonary pathologic conditions coincident to myocardial affections occur in a high per cent. Twelve out of one hundred and fifty-two cases showed specific gummatous lesions. Just what per cent of the fibrotic changes are due to syphilis cannot be proven, but it is probable that the lung is subject to the mild inflammatory processes which syphilis causes in other organs and eventually leads to fibrosis.

Dr. F. H. Baetjer. Certain Clinical Aspects of Peptic Ulcer with Special Reference to Roentgen Ray Diagnosis as Observed in 743 Cases. *Johns Hopkins Hospital Bulletin*, August, 1919, Vol. XXIX.

Report shows the close relationship between the clinical and roentgen ray examination.

The 743 cases were divided into three groups:

Group I. Cases proven by operation, 185.

Group II. Cases presenting positive clinical and roentgen findings, 323.

Group III. Cases of doubtful clinical findings and roentgen findings definite, 235.

Group I. 185 Cases

Age, 20 to 40. Sex, 132 males to 52 females.

Normal acidity	32 per cent
Hyperchlorhydria	41 " "
Hypochlorhydria and anacidity	26 " "
Roentgen findings were verified in	79.4 " "
Duodenal ulcers	46 " "
Gastric ulcers	36 " "
Pyloro-duodenal	11.5 " "
Undetermined	5.2 " "

Group II. 323 Cases

Roentgen findings confirmed	84	per cent
Duodenals	43	" "
Gastric ulcers	40	" "
Pyloro-duodenal ulcers	14	" "
Undetermined	3	" "
Pointing to other pathology	15.6	" "

Group III

Duodenal ulcer can always be ruled out. (Practically.) Gastric ulcer cannot always be ruled out.

Signs characteristic of gastric ulcer are those signs pointing to gastric irritation, as delayed emptying, hypermotility, tonic contraction of pylorus, deformity.

Signs characteristic of duodenal ulcer are:

Hypermotility of duodenum and stomach.

Pylorus not spastic, rapid emptying of stomach.

Simple duodenal ulcer empties in fifteen minutes to one hour. No hour glass.

Contractions uniform, pylorus open and bismuth flows freely, duodenum active and shows deformity same place. Two bismuth currents may be seen in cap.

Signs of gastric ulcer:

Primary quick expulsion and then spasticity of the pylorus.

Retention four to six hours.

Filling defect usually present.

Difficult are the complicated cases but investigation often clears up the diagnosis in a positive or a negative manner.

Mallory. Principles of Pathologic Histology. Textbook, pp. 580.

There are three gross tuberculous lesions of the kidney:

(1) Miliary tuberculosis.
(2) Tuberculous infarcation.
(3) Tuberculous nephritis.

Tuberculous nephritis is the most important form to us since it is chronic in type, and may be the only serious lesion in the body. It is due to the tubercle bacilli gaining

entrance to the pelvis of the kidney and causing a pyelitis. From here they infect the tubules and the intervening lymph vessels and tend to spread toward the cortex, causing necrosis and ulceration which start usually at the apices of the pyramids and gradually erode them. The lesion is analogous to tuberculosis extending along the bronchi of the lung. The process may result in the formation of numerous abscess cavities, some of which may reach the capsule of the kidney, or the whole kidney may be transformed into a succulated cavity filled with cheesy or putty like material.

Manner of Original Infection of Pelvis

(a) By a direct extension of a lesion of hematogenous origin into the pelvis or by bacilli being carried along a tubule from a lesion in the cortex.

(b) Extension of a process from lower down in the genito-urinary tract into the pelvis by way of ureter.

(c) Rarely by direct extension of a tuberculous lesion of an adrenal or other adjoining structure to the kidney, thence to the pelvis.

It has been claimed that tubercle bacilli pass through glomerule and lodge in the collecting tubules of the pyramids where they start an ascending pyonephritis. Evidence to prove this is lacking because it is never found in miliary tuberculosis.

Kelly and Burnham. Diseases of Kidneys, Ureters and Bladder. Text Book, Vol. II, pp. 19.

Most of our knowledge of tuberculous kidney has been elaborated in the past twenty years. The first recorded case is that of Margagni in 1767. This was a kidney made tuberculous from the extension of a contagious process, lymph glands.

Early it was thought that the tuberculous kidney was the end stage of tuberculosis of the genital tract. Later it was found the kidney was occasionally involved alone. Later in one-half the cases only one kidney was involved. Then the surgeons began to remove them boldly.

After this surgery of the kidney made rapid progress. Between 1890 and 1900 modern cystoscopy and catheterization of the ureters was born. This method of examination quickly showed that tuberculous kidney was often unilateral, demonstrated which kidney was involved.

1. Frequency of tuberculous kidney at autopsy without any reference to particular class of subject. 12,688 autopsies collected 603 tuberculous kidneys. 4.7%.

2. Frequency of tuberculous kidney at autopsy with active tuberculosis in other organs. Combining statistics—20.2%.

3. Frequency of kidney involvement in case of miliary tuberculosis. (Practically all.)

4. Relative frequency of miliary and caseo-cavernous form. (Two to one.)

5. The influence of age. Autopsy. In children, 15 per cent. In adults, 4.7 per cent.

6. The proportion of unilateral to bilateral caseo-cavernous tuberculosis.

Every caseo-cavernous begins as unilateral and remains so a long time.

Combining statistics 459, 253 showed only one kidney, *i. e.*, 55.1%. This would mean that even in extreme stages more than one-half unilateral.

In children both kidneys involved (caseo-cavernous type) twice as great chances both are involved.

In bilateral rarely both kidneys involved to the same degree.

In case with no tuberculosis elsewhere in body and bladder not involved. 100% unilateral.

Active tuberculosis in lungs means a greater probability that both kidneys are involved.

7. Frequency of primary renal tuberculosis without evidence of tuberculosis elsewhere in the body. Clinically cannot be shown, must be at autopsy. Only a few in literature as patients do not often die of tuberculous kidney alone. Clinically those that seem primary run 68 to 73 per cent.

Page 39, Figure 278, Photo. Kidney showing disseminated tuberculosis of cortex.

Page 41. Large tuberculous kidney. Photo.

Page 42. Tuberculosis limited to lower pole.

Page 43. Tuberculosis of the left kidney.

Page 44. Massive tuberculosis of the kidney.

Page 46. Massive tuberculosis of kidney and ureter.

Page 49. Tuberculous kidney with cystic transformation of upper pole.

Involvement of ureter in tuberculous kidney. Present to greater or lesser extent in all.

Page 51. Tuberculous kidney with dilated and constricted ureter.

Symptomatology

Chronic. Years. A few heal spontaneously after complete destruction of kidney and closed ureter.

Average symptomatic period three and one-half years.

Classes of Symptoms

1. General manifestations--weight, chills, sweat, fever. 30 per cent robust—40 fair.

2. Pain or tumor in affected kidney on palpation. Tumor never the first complaint, pain the principal in 10 per cent.

3. Bladder disturbance. Frequency and pain in micturition, incontinence of urine, strangury. This is the great and principal symptom. 70 initial—90% alone or in combination with others.

Changes in Urine

Hematuria—25%, small in amount. Turbidity—comes and goes.

Diagnosis

History. Palpation of kidney and ureter. Tuberculin of value. Old hypodermic method best.

Urinary examination: Pus, blood, tuberculosis, smears to rule out smegma, Guinea pig (when no pus it is delicate,

with pus pig is liable to die of pyogenic infection). Two to three who tuberculous lesions develop.

Cystoscopy, etc., tells

1. Bladder involvement.
2. Right or left. (Abnormalities as one kidney, etc.)
3. Typical ureteral orifice. (50%.)
4. Stricture of ureter and dilatation.
5. Functional activity of both.
6. Examination of the other kidney.

X-Ray

1. Outlines.
2. Size.
3. Calcification.
4. Pyelography.
   Outlining cortical abscesses.
   Location cortical abscesses.

The first session of the Louisiana State X-Ray Association, and the sixth session of the Texas Roentgen Ray Society, joint meeting, was held in the Grunewald Hotel, New Orleans, January 3, 1920.

The officers of the Louisiana State X-Ray Association:

Dr. Amedee Granger, President.
Dr. J. A. Gorman, Vice-President.
Dr. S. C. Barrow, Secretary-Treasurer.

Texas Roentgen Ray Society:

Dr. J. W. Torbett, President.
Dr. B. T. Vanzant, Vice-President.
Dr. S. D. Whitten, Secretary-Treasurer.

The

JOURNAL *of* RADIOLOGY

Published by the Radiological Society of North America

VOLUME I — February, 1920 — NUMBER 2

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TUBERCULOSIS OF THE KIDNEYS FROM THE ROENTGEN STANDPOINT*

E. W. Rowe, M. D.
Lincoln, Nebr.

I. Introduction
II. Roentgenography compared with other methods
III. History and autopsy reports
IV. Pathology
V. Clinical history and physical findings
VI. The roentgen method of diagnosis, with description of findings.
VII. Differential diagnosis
VIII. Conclusions

I. The purpose of this paper is to call attention to the value of the roentgen examination of the kidneys and ureters in the diagnosis of tuberculosis affecting the urinary tract. In looking over the literature it has been found, with one or two exceptions, that the method has not received general adoption as one from which deductions are safe and accurate. As our knowledge of each disease increases, we find through experience in plate interpretation and adapted technique an increasing safety in the roentgen diagnosis.

This paper is not meant to be a statistical study of cases. That will be left to workers where clinical material is more abundant. But I wish to call attention to the fact that the roentgen findings in renal tuberculosis are far more definite and positive than is generally understood. Even the unaided diagnoses outrun some of those pathological conditions in which the use is already standardized and accepted.

II. Roentgenography of tuberculous kidney should not be used as a short cut to diagnosis. It is but an addition

*Read before the Omaha Roentgen Society, March, 1920.

to the already heavily loaded armamentarium. But, however expensive in time or money, it gives increased accuracy to final deduction. The present-day conception of renal tuberculosis has passed through different stages. These may be marked by the following list of steps in every complete examination:

The old and time-honored methods
1. The clinical history
2. Physical examination

New method, scarcely twenty-five years old
3. Cystoscopy
4. Urethral catheterization
5. Roentgen examination
   a. Direct
   b. Indirect

Not one of these steps, once introduced, has been discarded. They make up the routine for every complete examination. Nothing should be omitted, but often the roentgenogram alone of a suspected kidney will contain definite and positive evidence of tuberculosis.

III. The modern conception of tuberculous kidney dates back scarcely more than twenty years. The first recorded case goes back to Morgagni in 1767. This was an uncommon type, even today: a kidney made tuberculous by contiguous tuberculous lymph glands. It was early thought that tuberculosis in the kidney was the end stage of tuberculosis in the urinary tract. Later it was discovered that one kidney alone was involved in one-half of the cases. After this, surgery of the kidney made rapid progress. Just before 1900 modern cystoscopy and catheterization were born. These methods quickly showed that tuberculosis was often unilateral and demonstrated which kidney was involved.

From the study of histopathology and autopsy reports the interpreter of plates must obtain the large part of that knowledge which aids him in a diagnosis. Compiled autopsies give some interesting facts.

Without reference to the particular class of subjects, 19,688 autopsies give 603 tuberculous kidneys, a per cent of 4.7. Another list of 6,000 autopsies gives 5.6 per cent. In cases with active tuberculosis elsewhere in the body, the number climbed to 20.2 per cent. When miliary tuberculosis was present, practically all the cases showed tuberculous kidneys.

The relative frequency of miliary and caseo-cavernous forms is as two to one. In autopsies of children the percentage of tuberculous kidneys runs to 15 per cent. The proportion of unilateral to bilateral caseo-cavernous tuberculous kidney must be explained to be understood. Of 459 cases reported as tuberculosis of this type, 55.1 per cent were unilateral. These autopsies represent extreme cases that died. The earlier in the involvement, the more likelihood there is of a unilateral tuberculosis. Clinically, the proportion of unilateral involvement runs to 90 per cent or above. (Bevan, Albarron, Kronlein, Israel.) In children, involvement of both kidneys is more likely. When both kidneys are involved, it is rare that both are involved in the same degree. In cases of bladder tuberculosis without a demonstrable tuberculous lesion outside the urinary tract, one hundred per cent had tuberculous kidney. Active tuberculosis in the lungs means a greater probability that both kidneys are involved.

Autopsies showing primary tuberculosis in the kidney without evidence of tuberculosis elsewhere in the body are rare. Clinically the ratio is as high as 60 or 70 per cent.

IV. There are three gross tuberculous lesions of the kidney:

1. Miliary tuberculosis
2. Tuberculous infarction
3. Tuberculous nephritis

Miliary tuberculosis does not concern the roentgenologist. It is acute and ends in death. Tuberculous infarction is very rare, and for practical purposes may be forgotten.

Tuberculous nephritis is the important form, and with its caseous areas, cavernous pockets, inspissated pus and calcium deposits, gives the most positive shadows upon the roentgenogram. It may be the only serious lesion in the body. Mallory gives the following concise statement of the histopathology: "It is due to the tubercle bacilli gaining entrance to the pelvis of the kidney and causing a pyelitis. From here they infect the tubules and the intervening lymph vessels and tend to spread toward the cortex, causing necrosis and ulceration which start usually at the apices of the pyramids and gradually erode them. The lesion is analogous to tuberculosis extending along the bronchi of the lung. The process may result in the formation of numerous abscess cavities, some of which may reach the capsule of the kidney; or the whole kidney may be transformed into a sacculated cavity filled with cheesy or putty-like material."

Renal tuberculosis is rarely acquired by adjoining structure, and only occasionally by extension upward in the urinary tract from a tuberculous infection lower. It is nearly always a direct extension from a lesion of hematogenous origin in the pelvis, or by bacilli being carried along a tubule from a lesion in the cortex.

V. The clinical history is often obscure. Some kidneys heal after a complete destruction and closure of the ureter. They may be discovered by accident or in a search for some vague group of symptoms. Nevertheless the typical course is chronic and is characterized by—

1. Systemic manifestations — loss in weight, or septic temperature. About 30 per cent of the patients will present themselves in robust health, 40 per cent in fair health, and the balance in poor health.

2. The earliest and most persistent complaint arises from bladder disturbance. In 70 per cent they are the initial symptoms; in 90 per cent they are alone or in combination with others.

3. Pain is uncertain and charcteristic in only 10 per cent.

The back and lumbar region are the seat. Palpation, if made, may demonstrate a tender mass. A tumor is never the presenting symptom.

4. The urine changes vary — sometimes turbid, sometimes clear. Hematuria with a 25 per cent incidence is usually small in amount, though brisk hemorrhage may occur.

VI. Roentgen evidence of a tuberculous kidney may be divided into (a) Indirect; or (b) Direct.

The indirect method depends upon the use of the cystoscope, ureteral catheters, and the use of opaque media. It is not the purpose of this paper to give a description of pyellography. It is in an advanced stage of development. But the roentgenologist must be in touch with its value in the diagnosis. The following points summarize its chief value and may be classified as indirect roentgen evidence:

1. Abnormalities, such as one kidney, or several ureters.
2. Stricture or dilatation of the ureter.
3. The determination of the presence or health of the opposite kidney.

The cystoscope adds the following valuable information when it can be employed:

1. The presence or absence of bladder involvement.
2. The condition of the ureteral orifice. In 50 per cent of the cases the orifice on the affected side will be typically inflamed.
3. A determination of the function of both kidneys.

In our clinic we are now using a 32 per cent solution of sodium bromide for the opaque media. We found that it gives a clearer outline, is non-irritant and completely absorbed in a few hours. Besides, it is cheap and easily sterilized by boiling.

The injected media shows the relation of suspected shadow to the kidney and outlines the injured kidney or dilated ureter in a typical manner. Inflammatory dilatation of the pelvis when caused by tuberculosis is larger and more irregular and confined to the calyces. When the cortex becomes the seat of necrosis the pelvic outline may

disappear in the part affected, or completely. The media will then show indistinctly and disappearing into the parenchyma. Irregular forms appear, or the entire kidney may be sac-like.

The renal outline itself is of little value in showing size or pathologic contour. The possibility of error is too great.

The roentgenographic shadows of tuberculous deposits are due to the presence of calcium. They assume various forms, from scattered foci to complete calcification as found in the putty-kidney. They are less dense than stones and the outlines are not sharp, but grade off into the surrounding tissue. They may appear as elongated, isolated streaks, or as multiple, sharply defined areas in one pole or the other. The size of the shadow in no way indicates the extent of the tuberculous process. Large caseated kidneys may cast no shadows. On the other hand, enough calcium may be at hand to give a complete cast of the kidney.

Braasch gives accurate statistics showing that not only do one in five of their cases operated upon for tuberculosis of the kidney give roentgen findings, but that 70 per cent of these are positive and typical. This is a step further than any other writer has gone on record. The number of kidney shadows recognizable is largely a personal equation. But the fact remains that study and experience make it possible to recognize a higher percentage than in the past. Histopathology gives different form and density to the resulting shadows. The result will depend largely upon the individual ability of the observer to translate into roentgen terms the histopathology.

VII. From our present knowledge it is obvious that the differential diagnosis cannot always be made. Careful checking of corroborating evidence should make it fairly safe to rule out (1) gallstones, (2) mesenteric, and (3) glandular areas of calcification. The location, and the concentric layers of deposited calcium or faceted surfaces, should distinguish them. (4) Renal stones are more dense, often brilliant, usually sharply outlined, and rarely in the

opposite kidney. Here, not infrequently, the differentiation cannot be made.

CONCLUSIONS

1. The interpretation of tuberculous shadows in roentgenograms of the kidneys becomes more definite and more accurate, as in all other parts of the body, the more often they are seen.

2. The direct method should be employed in all suspected cases of renal tuberculosis.

3. The indirect method should be employed in all cases of doubtful infection, and those in which direct interpretation needs corroboration.

4. The roentgen method should be the routine in all cases of examination of the urinary tract.

5. A roentgen examination of the lungs should be made in every case of renal tuberculosis. If no active tuberculosis is found in the lungs, the chances are very great that the involvement is unilateral and therefore operable.

BIBLIOGRAPHY

1. Diseases of the Kidney, Ureters, and Bladder. Kelly and Burnham, Vol. II, p. 19.
2. The Use of Sodium Bromide in Radiography. Collected Papers Mayo Clinics, 1918, Vol. X, 963.
3. Radiographic Diagnosis in Renal Tuberculosis. Collected Papers Mayo Clinics, 1918, Vol. X, 2.
4. Principles of Pathologic Histology. Mallory, page 580.
5. Differential Diagnosis of Nephroliasis from Renal Tuberculosis by Roentgenography. Krotoszyner, Jr. A. M. A., 1914, lxiii 2006-9.
6. Roentgen Interpretation. Holmes and Ruggles, page 198.
7. Modern Medicine. Osler and McCrae, Vol. V, p. 98.
8. Surgical Diagnosis. Johnson, Vol. II, p. 454.

THE MODERN TREATMENT OF CANCER OF THE UTERUS WITH THE COMBINED SURGICAL AND RADIOLOGICAL METHODS

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The treatment of cancer must be based on a painstaking physical examination. The findings obtained will enable us to determine: 1, whether the growth is localized in the invaded organ or region of the body; 2, whether it has extended into the neighboring organs and tissues; 3, whether it has invaded the regional lymphnodes; 4, whether secondary cancers have occurred in distant organs or tissnes, and 5, whether other organic and constitutional diseases, such as uncompensated heart disease, chronic Bright's Disease, pulmonary tuberculosis, diabetes mellitus, and so forth, coexist. Should the malignant disease be clearly localized it is curable. A complete surgical eradication will suffice to totally remove or destroy all of the abnormal cell elements. Therefore, if patients afflicted with cancer disease would apply for treatment to the surgeon during the localized or incipient stage of the disease, the question of how to permanently cure cancer would be a very simple one to answer.

However, clinical experience teaches that a radical cure of cancer is a difficult matter. For instance, abdominal radical panhysterectomies for carcinoma of the uterus are followed by recurrences in about sixty per cent during the first year and in an additional fifteen per cent during the second year following the operation. How may this deplorable state of affairs be explained? The cancer victim seeks relief at a time when the disease is not any more confined to the uterus. Obviously a careful physical and bimanual examination would have enabled the surgeon to recognize the ad-

vanced state of the disease and pronounce the case inoperable and hopeless from a surgical standpoint. In other instances extension of the disease into neighboring organs or tissues cannot be determined in spite of an honest and careful investigation, a fact that is excusable. Again, in other cases, a correct diagnosis was not made at the first presentation of the patient, due to carelessness or inability to make the examination. Such a condition is inexcusable and criminal. If physicians would resolve to arrive at a correct diagnosis in every patient in the shortest possible time, or failing to do so refer the patient to someone who could, the percentage of cures of cancers would soon increase. Finally, a large number of cases remain that come to the clinic with advanced cancer disease. The patient, though ailing, did not realize the import of ill-health. It is, therefore, our duty to enlighten the public on the insidious onset of the disease, to teach it the cardinal symptoms that uterine cancer evinces, and to impress upon it the truth that cancer is curable if surgically eradicated in the beginning, that is, localized stage.

The examination of a cancer patient has as its object not only the diagnosis, but comprises the determination of the extent of the disease and the recognition of co-existing or complicating diseases. It would lead too far to discuss this subject in all its details, but we may enumerate the various steps of the examination. These are: 1, an exact history; 2, a careful general physical examination; 3, painstaking bimanual vaginal and rectal examination, and 4, special endoscopic examinations of the rectum and urinary system.

The digital rectal examination enables us to recognize invasion of the regional lymphnodes and the parametria. Cystoscopic examination reveals an invasion of the bladder; urethral catheterization may elicit obstruction of the ureter either by pressure or cancer invasion. By a proctoscopic examination we may recognize an invasion of the bowel, a fact which would have escaped a digital exploration.

A localized cancer is curable and operable. A cancer

that has invaded neighboring tissues or regional lymph-nodes is doubtfully curable by operative measures and is termed a border-line case. A cancer which has extensively invaded one or both parametria or the bladder in front or the rectum behind is inoperable. Co-existing complicating diseases may render the patient a bad surgical risk and, therefore, surgical treatment is out of the question. The indications for operative treatment must be solely based upon these facts.

One hundred and sixty-five cases of carcinoma of the uterus came under my care from April 1, 1914, to October 1, 1919. Twelve of these cases, or *i. e.* 7.27 per cent, were clearly operable, and twenty of these cases, or *i. e.* 12.12 per cent. were borderline cases, hence doubtfully operable. In other words, out of one hundred and sixty-five cases only thirty-two cases, or 19.39 per cent, could justifiably be subjected to an extended radical extirpation. If the statistics on efficiency of surgical treatment were applied to these thirty-two cases, then at the end of two years only about fourteen patients would have survived without a recurrence.

"The total number of cures of 1090 cases were 386 or 35.41 per cent of traced cases, or 19.32 per cent of cases operated on, or less than 11.72 per cent of cases applying for treatment." (Janeway-Surg. Gyn. & Obst., Sept., 1919.)

Indeed surgical treatment of cancer has been very unsatisfactory in the majority of cases and it is not surprising that we are straining all our efforts towards an improvement of the treatment of cancer in other directions. Since the advent of the modern transformer, the Coolidge hot cathode tube and the radio-active substances chiefly mesothorium and radium the discussion of the subject of cancer treatment has received a renewed impetus.

We must always realize that success in cancer treatment can only be obtained by the complete eradication or degeneration of absolutely all cancer cells present in the body of a victim of the disease. This principle must be observed if we are to expect results whether the means chosen are sur-

gical or radiological. The danger in the treatment of cancer with surgery consists in the fact that we cannot always remove all tumor tissue. The vestiges left grow with an increased rapidity and by auto-transplantation cause secondary growths in different parts of the body. The danger in the treatment of cancer with radio-active substances lies in the fact that proliferation is enormously stimulated if we cannot rapidly destroy all the pathological cells. An accelerated proliferation increases the danger of the formation of metastases. Earlier diagnosis has doubtless contributed to improving surgical statistics and is equally important for roentgen and radium therapy. In these directions lies the hope of real advance in the therapeutics of uterine cancer.

The demonstrable reduction in the size of a tumor of a kind not to be attributed to the natural process of evolution of that tumor or its associated lesions is the one essential feature of effective therapeutic intervention. Circulatory changes in the tumor, the cessation of hemorrhage, the relief of pain, the restoration of a secondarily impaired function or local healing cannot be cited as an indication of the specific curative action of the agent employed. The growth may continue to advance in spite of their presence. We should exclude from the consideration of the curative action of an agent all of these secondary factors. The observation of the size of the tumor itself is the sole criterion on which we can place reliance in judging of the effect of the therapeutic measures.

Surgery will remove cancer tissue and organs but cannot change the characteristics of the abnormal cells. The hard roentgen rays and the gamma rays of radio-active substances can modify cancer tissue and cells but cannot remove them. Surgical eradication of carcinoma of the uterus is so frequently followed by a recurrence because either an auto-vaccination of active virile cancer cells took place during the operation due to the inevitable trauma, or vestiges of carcinoma cells have inadvertently been left behind. If

the growth had been intensively rayed to destroy the boundless proliferative activity of the cancer cells the accidents of surgery would have been minimized or rendered impossible. An application of roentgen and gamma rays of sufficient intensity and extent to include all of the tumor mass and the regional lymphnodes will stunt the growth within ten to fourteen days on account of the arrest of mitosis of the carcinoma cells. If we keep these facts in mind we can approach the solution of the technique of cancer therapy with some prospect of benefit. If the case primarily was in an operable stage the excision should now follow. Another seance of combined roentgen and gamma rays is given as soon as the patient has recovered from the effects of the operation.

The patient must be requested to return for re-examination every six weeks during the first year and every three months during the second year and thereafter on the appearance of even mild symptoms of ill-health such as painful urination, difficulty in defecation, vaginal discharge or the slightest indisposition. If a recurrence should take place the same plan of treatment is again adopted, that is a course of ray-therapy followed by the operation if the recurrence is operable.

In borderline cases the question arises whether an operation would be insisted upon, or whether it is preferable to confine one's efforts to ray therapy. We had twenty cases in our total of one hundred and sixty-five. Thirteen were subjected to a combined surgical and radiological treatment, while seven were treated only with roentgen and radium rays. Our results seem to indicate that the patients treated with rays fared better in both immediate and remote results than those treated with a combination of surgery and rays. However the time elapsed is not yet of a sufficient duration to allow us to render a definite opinion.

In absolutely inoperable carcinomata of the uterus we solely have recourse to radiotherapy. Should a local healing and a reduction in the size of the tumor ensue, so that

the tumor seems to be localized within the uterus the question arises whether we should or should not resort to surgical eradication. Out of a total number of seventy-three cases we subjected thirty-six cases to operation, sixteen to panhysterectomies and twenty-one to very thorough vaginal cauterization with the hot soldering iron, while thirty-seven cases were treated with rays only. The results plainly are in favor of the last procedure. Only five patients remain alive in the first group, but thirteen in the second group. Thirty-two died or were not even improved by the combination treatment and twenty-four of the second class either died or were not improved. The duration of life following the combination treatment of those known dead is nine plus months, while it is twelve plus months in the second class. Therefore the patients were not only unnecessarily subjected to severe physical sacrifices, but fewer survived the ordeal and the duration of life of those, known dead, was also markedly reduced.

We next wish to discuss the technique of the ray-treatment observed in our clinic. We always use a combination of roentgen and radium rays. The equipment used to carry out the roentgen treatments consists of a transformer with an autotransformer current controller and a Coolidge tube. We use two methods: the crossfire method with a large number of small fields and the homogeneous method using two large portals of entrance.

The crossfire method is carried out as follows: The Coolidge tube is charged with a current of five milliamperes of ninety kilovolts as determined with the auto-transformer control. The rays are filtered through an aluminum plate of 4 mm. thickness. The focal distance is seven inches. The number of fields is from seven to twelve in the suprapelvic region and from four to eight fields divided over the perineal, sacral and buttocks regions. Thus from ten to twenty fields are used. Each field is one and one-half inches square. The duration of the application is ten minutes over each field, but may be extended to thirty minutes without

causing serious injuries in the skin. The erythem dosage obtained within ten minutes above the filter is six and on the skin surface one, or eighteen and three respectively if thirty minutes are used. Therefore a total of sixty to three hundred erythem doses is given during each seance of treatment. The ten minute seances are repeated after fourteen to twenty-one days for three times.

The homogeneous method is carried out in the following manner: The Coolidge tube is charged with a current of five milliamperes of a current of one hundred to one hundred and twenty kilovolts controlled by the auto-transformer. The filter consists of a 1 mm. copper plate and one thickness of sole leather. The focal distance is 24 inches. One field 9 inches square is used anteriorly and another one posteriorly over the sacrum. The application to each field is about one hour. The erythem dosage on the skin being 1.25 E. The difference in intensity of the ray at the skin level and the posterior pelvic wall is negligible. Therefore practically the same stream of rays passes through the pelvic structures assuring a complete and uniform penetration.

We are at work building a transformer that will deliver a current of 150 to 180 kilovolts and a tube that will carry this load. We are convinced that results will materially improve with the use of the latter method.

The method of measuring the erythem dose also is very incorrect and we are engaged at present in measuring the rays delivered at the posterior pelvic wall by a specially constructed ionisation chamber that can be inserted in the rectum and is connected with an electrometer provided with an indicator registering the number of electrostatic units obtained within a fixed time period.

In stating dosage of gamma radiations of radium we must observe:

1. Quantity of radium in milligrams of the element.
2. Filter, rubber filter and other wrappings used, such as gauze.

3. Distance of radium from area to be treated.
4. Time duration of exposure.
5. Intervals between each series of exposures.

In estimating the dosage in a given case, we must always consider that the cancer must be completely destroyed and that the dose applied must not produce serious injuries of the surrounding healthy tissues and organs which would render illusory the first object. The minimum dosage for destruction of cancer epithelium is on an average half as large as the minimum dose for the destruction of healthy skin epithelium. Exceptions are glandular carcinomata. The maximum dose is that necessary to destroy cancer without injury to healthy tissues. It can only be obtained by deep therapy in pelvic carcinomata. It is the object of deep therapy to influence by the rays deeply located pathologic processes in the body through layers of healthy tissue overlying the former without permanent injury to the latter.

The maximum dosage can only be determined by the biologic measurement of each radium preparation. If fifty milligrams of radium element contained in a tube as usually employed in gynecological work are filtered through 1 mm. of brass, 3 mm. of para rubber, 5 mm. of gauze and a finger-cot, then the maximum dose for healthy skin is one to one and one-half hours. The exposure causes no visible reaction. If the application is continued then a reddening of the skin occurs at about one and a half hours, an erythem dose; at two and a half hours it causes a blistering of the skin, a burn of the second degree, the lethal dose for healthy epithelium. If the application is continued for twenty-four hours then a burn of the third degree is caused in the epithelium, while the dose may be still considered lethal for connective tissue, *i. e.*, the connective tissue is not permanently destroyed or damaged.

To estimate the maximum doses for the destruction of a uterine cancer we must recall to our mind the exact abnormal conditions found in the pelvis in this disease. The

vaginal portion of the cervix lies in the interspinal line. The cervix and lowest part of the body with the parametria lies somewhat higher. Cervical cancers spread by invasion of the vaginal vault, by infiltration of the lymph vessels of the lateral parametria, the paravaginal tissues, along the sacro-uterine ligaments to the pararectal tissues and rectum, and through the vesico-vaginal septum to the bladder. The part of the pelvis between the pelvic outlet and a mid-pelvic horizontal plane contains all these structures and is the space which must be rayed. The transverse and antero-posterior diameters of the midpelvic plane are twelve centimeters in length, while the transverse diameter of the pelvic outlet is twelve centimeters and the antero-posterior diameter is eleven and one-half centimeters. Hence if radium is inserted into the cervical canal which lies in the pelvic axis, the rays must reach a penetration of five and one-half to six centimeters. We must avoid injuries to the ureters, bladder and rectum. They are on an average one and one-half centimeters distant from the cervical canal, if the hollow organs are empty. Should the bladder or rectum be filled, they are forced closer to the cervix and the distance is reduced by about one-half. Therefore it is desirable that bladder and rectum be empty and left empty during the treatment.

We may overdose the depth of one and a half centimeter to such an extent that the maximum dose for normal epithelial tissue is obtained at one and a half centimeter without injury to the ureters, bladder and rectum. Thus we may use a dose nine times the maximum of a surface epithelial erythem dose. Observing the law of the inverse ratio, and stating that the intensity of the rays is 100 at a distance of one centimeter, then it is one-fourth at a distance of two centimeters, one-ninth at three centimeters, one-sixteenth at four centimeters, one-twenty-fifth at five centimeters, one-thirty-sixth at six centimeters, and one-forty-ninth at seven centimeters. Since the maximum dose for cancer tissue is one-half that of normal epithelial tissue,

and the maximum lethal dose for normal epithelial tissue is reached at two and one-half to three hours, with fifty milligrams of radium at a distance of one centimeter it is attained in cancer tissue in about one and one-half hours. This we have repeatedly proven in skin cancers, where the depth of the tumor could be exactly gauged. Further if at one centimeter distance a destruction of cancer cells is obtained in one and one-half hours, at two centimeters it is obtained in six hours, at three centimeters in thirteen and one-half hours, at four centimeters in twenty-four hours, at five centimeters in thirty-seven and one-half hours, and at six centimeters in fifty-four hours. Therefore the application of fifty milligrams of radium element properly filtered must consume fifty-four to sixty hours to destroy all cancer tissue in a pelvic cancer. The maximum dose at one and one-half centimeters for the normal bladder and rectum epithelial tissues is reached at about twelve hours. We may assume that if a dose is applied for only ten hours it destroys cancer tissues within two centimeters while the healthy bladder and rectum epithelium is not injured to cause permanent damage. If a sufficient interval is left between subsequent applications, the normal tissue regenerates, so it will bear another exposure without permanent injury, while the cancer tissue, however, is permanently damaged and cannot regenerate. Thus the plan of the intermittent application was developed. Fifty milligrams of radium element properly filtered are inserted on six to seven successive days for ten hours each day. Strictest asepsis must be observed. It is also advisable to maintain free drainage from the uterus. The rapid disintegration of cancer cells liberates besides antigens, hemolytic and proteolytic ferments. If drainage is obstructed or prevented they may lead to hemolysis and proteolysis and cause grave disturbances of the general health.

The reasons why we do not apply the total dosage in one sitting is to prevent destruction of healthy organs and to avoid severe auto-intoxication.

Results

From April 1, 1914, to October 1, 1919, one hundred and sixty-five cases of carcinoma of the uterus were treated. For a study of the clinical value of ray therapy, we have divided the cases into five groups.

Group 1. Cases which were clearly operable after a physical examination.

Group 2. Cases which were doubtfully operable.

- (a) Cases subjected to surgery and ray therapy.
- (b) Cases subjected to ray therapy only.

Group 3. Cases in which an operation was absolutely impossible.

- (a) Cases subjected to abdominal hysterectomy and radium and ray therapy.
- (b) Cases subjected to vaginal cautery and ray therapy.
- (c) Cases subjected only to ray therapy.

Group 4. Cases so far advanced that all treatment was hopeless. They were subjected to ray therapy for purposes of palliation.

Group 5. Cases that recurred after an abdominal panhysterectomy.

The following table shows the total number in each group and the results to date.

Group	*Total Number*		*Living*	*Died*	*No Report or Improvement*
1	12		10	2	
2a	13		7	3	3
		20			
2b	7		5	2	
3a	16		2	11	3
3b	21		3	8	10
		73			
3c	36		11	12	13
4	28		1	13*	14
5	32		5	11	16
	165		44	62	59

*Three died within a day or two after the treatment from severe toxemia.

A study of all the tables demonstrates at once the importance of early diagnosis and treatment. We can only hope for improvement in cancer cure statistics by instituting measures resulting in an earlier recognition and immediate proper treatment of these carcinomata.

The clearly operable cases make a remarkable and favorable showing. There are two deaths in a total number of twelve cases treated. The cases surviving do not evidence a sign of recurrence at the present writing.

In Group 2 twenty cases were treated. Of these thirteen were subjected to operative and ray therapy. Of these seven are living while six either died or did not report. Of the seven cases treated only with rays five are living and two died. It is impossible to state whether an operation should have been performed or not as the cases are too few and too recent to permit a conclusion. But it appears to us that surgical eradication does not materially influence the results for the worse.

It is not surprising that Group 3 should give us the largest number of cases, namely seventy-three. Of these sixteen cases were subjected to hysterectomy either before ray therapy was begun or after a local healing was obtained with ray therapy. The results were disastrous. Only two patients so far have survived the ordeal. Twenty-one cases were subjected to an initial vaginal cautery before radium was applied. Three patients survive to date, while the average duration of life in those known dead is twelve months. On the other hand eleven of the thirty-seven patients treated only with radium therapy are well at the present writing. The duration of life of those that died in class (a) is nine plus months, in class (b) twelve minus months, and in class (c) twelve plus months. In other words the patients in the latter class had a better chance all around than those in the former. We must conclude that if local healing is obtained, the tumor is arrested in growth and the infiltration of the parametria subsides, we should not subject the patient to an unnecessary operation.

Group 4 demonstrates one fact. An advanced cancer patient should be treated only with ray therapy to relieve the symptoms. This is all we can hope for. But little benefit is obtained for the efforts spent.

The intensive intermittent plan of treatment cannot be carried out in this class of cases as the rapid degeneration of tissue invariably causes a severe autointoxication. A period of from four to eight days should intervene between applications, that is until the reaction has subsided.

Group 5 shows a few brilliant therapeutic results. Recurrent carcinomata are very refractory to radium treatment. Comparing this group with Groups 1 and 2 we must state that a combination of surgical treatment and ray therapy shows such favorable results that surgical eradication of carcinomata must always be combined with an intensive ray treatment. If we procrastinate matters and postpone the latter until recurrences appear, and they do appear in about 75 per cent of the cases within the first two years following the operation, then ray treatment also cannot improve the outlook in the majority of cases. It is our opinion that the sooner after operation the recurrence took place the better the palliation from ray therapy.

A good deal has been said about the efficacy of emetine given intravenously in carcinomata. We employed it in twenty-five consecutive cases, six of which were uterine cancers. We did not see a single benefit occur to the patients, but found that they developed a severe weakness, a rapid and weak heart, loss of weight and strength and so forth, not to mention two immediate deaths and other transitory but alarming accidents attributable to the emetine.

Considering that surgery can remove carcinoma tissue, but not change the boundless proliferative activity of the cancer cell and that radium and the roentgen rays will arrest the active mitotic power of cancer cells but can not remove them, it is obvious that in the treatment of cancer disease we must resort to the combined method of treatment

provided the case in question is a clearly operable or doubtfully operable one. However, if the case is absolutely inoperable or recurrent we must confine the treatment solely to ray therapy. The hopeless case remains hopeless even if ray therapy has been carefully carried out.

Ray therapy is still in an experimental stage. As experience enlarges we will be enabled to form an exact technique. Results then will obviously be improved.

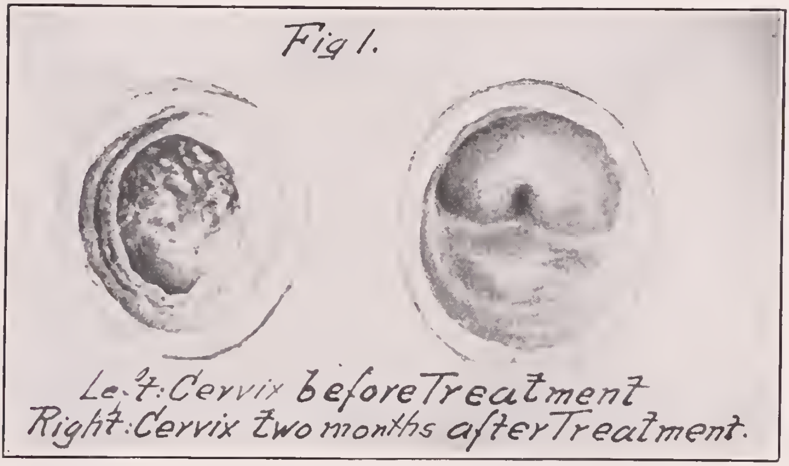
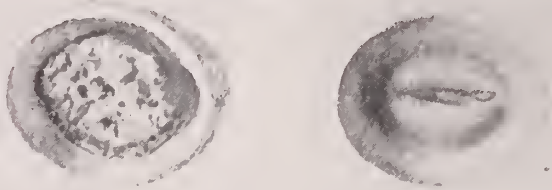


Fig. 3.



Left: Cervix before Treatment.
Right: Cervix Five Weeks after Treatment.

Uterine Cancers.
Table I. Classification.

Group I. Cases which were clearly operable after a physical examination.

Group II. Cases which were doubtfully operable „Borderline Cases."
- a. Cases subjected to Surgery and Ray Therapy.
- b. Cases treated with Rays only.

Group III. Cases in which an operation was absolutely impossible.
- a. Cases subjected to abdominal Panhysterectomy and Raying.
- b. Cases subjected to vaginal Cautery and Raying.
- c. Cases subjected to Raying only.

Group IV. Cases so far advanced that all treatment was hopeless. They were subjected to Raying for purposes of palliation.

Group V. Cases that recurred after surgical eradication.

Group.	Total Number	Living	Died	No report or improvement.
I	12	10	2	
IIa	13	7	3	3
IIb	7	5	2	
IIIa	16	2	11	3
IIIb	21	3	8	10
IIIc	36	11	12	13
IV	28	1	13	14x
V	32	5	11	16
	165	44	62	59

x Three patients died within a few days from treatment

Table 2. Time elapsed since treatment in living and dead.

Group I					Group IIa					Group IIb				
Living		Dead		No Report	Living		Dead		No Report	Living		Dead		No Report
yrs	mths	yrs	mths		yrs	mths	yrs	mths		yrs	mths	yrs	mths	
5	2	1	10		4	8	2		3	2			1	
4	9		7		2	9	1			1	6	1	2	
3	6				2	6	1	5		1	4			
2	5				1	7				1	2			
4	6					8				1	3			
1	8					9								
1						6								
	9													
1	3													
1	2													
10		2			7		3		3	5		2		
Total 12					Total 13					Total 7				

Table 3.

Group IIIa					Group IIIb					Group IIIc				
Living		Dead		No Report	Living		Dead		No Report	Living		Dead		No Report
yrs	mths	yrs	mths		yrs	mths	yrs	mths		yrs	mths	yrs	mths	
	6		4	3	2	9	1	1	10	2	2		7	13
	4		2		2	7		8		1	2	2	10	
		2	7		2			2			10		8	
			5				1	6			10		2	
			3					3			10	1	4	
			5				2	1			8	2	1	
			7				1	8			5		8	
			3					6			5	1	3	
		2									4	1	4	
			10								3		8	
			8								3		10	
													2	
2		11		3	3		8		10	11		12		13
Total 16					Total 21					Total 36				

Table 4

Group IV					Group V				
Living		Dead		No Report	Living		Dead		No Report
yrs	mths	yrs	mths		yrs	mths	yrs	mths	
4			4	14	3	3		11	16
			2		3	1		5	
			1		2	4		1	
			5		1	4	1	7	
			5			10		8	
			7				1	4	
			2					6	
			2					3	
			2					8	
			0					4	
			5					9	
			0						
			0						
1		13		14	5		11		16
Total 28					Total 32				

PHYSICAL FACTORS UNDERLYING THE USE OF RADIUM AND RADIUM EMANATION

GERALD L. WENDT

I. THE RADIATIONS FROM RADIUM SALTS

The complexity of the radiations from an ordinary tube of radium can hardly be overemphasized. The mere division into three classes, alpha, beta, and gamma, is only a preliminary step, for there are present in every such tube at least seven, and usually more, distinct elements, each of which has its own characteristic rays, of one, two, or even all three of these classes, and each of these is incomprehensibly complex. In the clinical use of radium this complexity is often lost sight of, a fact which has hampered the development of radium therapy.

It is well known that these rays arise from the explosions of the radioactive atoms themselves, and that we are here dealing with a source of energy quite different from the usual types. Realization of the amount of this energy is not so common. Radium keeps itself constantly two or three degrees above the temperature of its environment, due to the absorption of its own rays. The heat thus evolved amounts to about 134 gram calories per hour from a gram of radium in equilibrium with its decomposition products. Of this 25 calories come from the radium itself, and 109 from the gaseous emanation and its products. A brief calculation shows that one cubic centimeter of the emanation under these conditions gives no less than 24,-300,000 calories before it ceases radiating energy. That this is a stupendous quantity of energy can be shown by comparison with the heat liberated from an ordinary chemical reaction. One cubic centimeter of mixed hydrogen and

oxygen gives, in one of the most energetic of all known chemical reactions, two calories. The same quantity of radium emanation gives more than ten million times this quantity. Obviously the two are not comparable. In the one case we are merely scratching the surface of the atoms. In the other deep-seated changes take place, and a large fraction of the total energy contained within the atom is made available. Radioactive change of one element into another is a wholly different thing from a chemical reaction. Even the analogy of comparing the chemical heat with the water evaporated from the surface of a watermelon and the radioactive energy to the entire water content of its interior falls short of the truth.

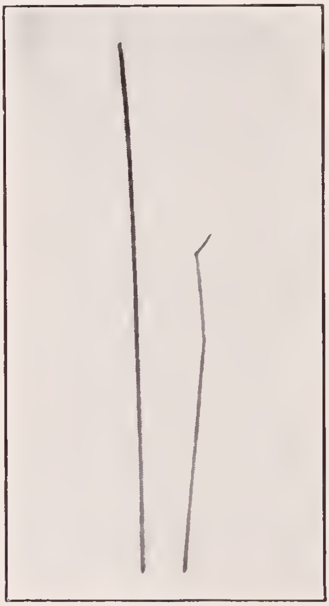


FIGURE 1

THE STRUCTURE OF THE ATOM

The anatomy of the radium atom needs to be understood before the distinction becomes clear. This was first deduced by Sir Ernest Rutherford from experiments made by

himself and by C. T. R. Wilson. The latter succeeded in making photographs of the trajectory of an alpha ray in its course through a gas. One such photograph is reproduced in Fig. 1. The fact of note is that the swiftly flying alpha particle suffers two very marked deflections, presumably in colliding with atoms of oxygen or of nitrogen in the air. This is a rare exception. In general these particles pass without hesitation through the atoms which lie in their path. Even thin sheets of gold or of glass do not stop the rays and bend only a very small proportion out of their path. The sharp deflection in the photograph was not due to any impurity in the air, and since many other atoms of gas were passed through without incident it follows that in these particular two collisions the alpha particle must have struck the gas atom *in some unusual part of its anatomy.* Hence Rutherford concluded, from this and many other similar experiments, that almost the entire mass of an atom is concentrated in a very dense nucleus at its center and that in these two collisions the alpha particle passed very close to this dense nucleus, while in the ordinary collisions it passed through the relatively empty exterior of the atom. This nucleus theory of the atom has been elaborated mathematically, and has furnished the explanation of so many otherwise unintelligible phenomena that it is now almost universally accepted.

On this theory the diameter of the nucleus is about 10^{-13} cms. This is only one hundred-thousandth of the diameter of the hydrogen atom, 10^{-8}, yet practically all the mass of the atom is condensed into this nucleus. The outer part of the atom is composed of rings of electrons in rapid motion, like planets about the sun. To these electrons the chemical properties of the various elements are due, and it is with this exterior that we usually deal. In radioactivity, however, we are only incidentally concerned with the electrons: the rays come from the nucleus. It is only by means of the rays that we obtain any information as to the nature or even the existence of the nucleus. A complete study of the

structure of the nucleus has recently been made by W. D. Harkins.[1]

The Alpha Ray Disintegrations

While the planetary electrons are knocked out of the atom very easily, the nucleus is very stable in all atoms except those which for some reason are "radioactive". In these the nucleus explodes. Of course each radium atom can explode but once, for what remains cannot be radium; it is, in fact, quite a different substance. Whether any individual radium atom "lives" for a second or for millions of years is a matter of chance. But with the enormous number of atoms in a gram this chance becomes a certainty and the number of radium atoms which explode per second is strictly proportional to the number present. Of every million radium atoms present at any time 346 will explode per year or about 0.00001 per second. With 100 billion radium atoms one explodes per second. Since there are 10^{21} atoms in a gram of radium, however, such a gram gives ten billion such explosions per second. This means that in about 1800 years any quantity of radium will have been reduced to one-half its original amount.

Now, as stated above, the energy liberated in these explosions is tremendous. What happens is the ejection from the nucleus of a smaller nucleus, four units in atomic weight, at a velocity of 1.6×10^9 centimeters or about 10,000 miles per second. All radium explosions emit these particles, the "alpha rays", which are really nuclei of helium atoms, at this same velocity. On encountering material obstacles they give up their energy in collisions and are reduced to a velocity such that we can no longer detect them when they have gone through 3.3 centimeters of air. Since they all have the same velocity they all go just this same distance before they are lost, so that this distance is characteristic and is known as the "range".

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[1] The Nuclei of Atoms and the New Periodic System. *Physical Review*, 15, 73, February, 1920.

What remains of the original radium atom is of course projected in the opposite direction according to the laws of momentum at a velocity which is relatively smaller because of the greater weight of the particle, namely, 222 units of atomic weight, radium itself having an atomic weight of 226. These are called the "recoil atoms". They are no longer radium. Not only has the nucleus lost four units of weight in the explosion, but, since it is composed of positive electricity, and two units of positive electricity go off with the helium nucleus, what remains is negatively charged due to the excess of electrons on the outside of the atom. This cannot last, however, and two electrons at once drop off. But these are valence electrons and hence the new atom has a valence two less than the radium. Now radium is in the group of the periodic system with barium, and has a valence of two. The new atom therefore has a valence of zero, and is, in fact, a member of the group of noble gases in the periodic system, along with neon, argon, etc. It is called niton, or more usually, radium emanation. Why it is a gas rather than a solid is not clear, but it is in every respect a chemically inert gas just like the other gases of that group.

These atoms of the emanation are much less stable than those of radium. One out of every 500,000 explodes per second, and any quantity is thus reduced to half value in a little less than four days. Starting with pure radium, there will of course at first be no alpha rays from the emanation, and during the first minutes after purification the emanation will be so small in quantity that the rays from it will be but a small fraction of those from the radium. As time goes on, however, more and more rays come from the emanation. Take 100 billion radium atoms to start with. One explodes per second. When 500 have thus been converted into emanation these latter will be exploding at the rate of one every thousand seconds. By the time 500,000 atoms of emanation have formed, they will be exploding at the rate of one every second. Hence they are exploding as fast as they are formed. No quantity in excess of these

500,000 can thus be accumulated at any one time from this amount of radium. The two are said to be "in equilibrium". This will occur within a month after all the emanation has been separated from the original radium.

The emanation has a shorter life than the radium. Along with this goes a greater energy of explosion. Its alpha rays are projected with a velocity of 1.7 x 10^9 cms. per second and have a range of 4.2 cms. in air. They all have the same velocity and range, but these are different from those of radium itself. The range of the alpha rays can thus be used as a test to distinguish the two substances. Indeed every radioactive substance that emits alpha rays has its own characteristic range, dependent only on the energy with which it explodes.

The product of the explosion of the emanation atom, called Radium A, has an atomic weight of 218 and is again two places to the left in the periodic system. It is thus in the sixth group, since the zero group and the eighth group are chemically the same in this regard. It thus resembles tellurium and has a valence of six. It also is unstable, even more so than the emanation. One out of every 250 atoms explodes per second, so that it is reduced to half value in three minutes. Thus for every 500,000 emanation atoms, and for 100 billion radium atoms only 250 atoms of this Radium A can be formed before it decomposes as fast as it is formed. It rapidly reaches equilibrium and emanation is thus never handled free from it. It can however be distinguished by its longer range, which is 4.75 cms.

In a similar way the life periods and ranges of the one further product that gives alpha rays, Radium C′, can be distinguished. Radium B is an intermediate product which does not give alpha rays on exploding, and will be discussed later. After Radium C″ comes Radium D, whose period is so long and whose activity is therefore so small that it need not be considered.

Thus every sample of radium in a sealed tube gives out four different kinds of alpha rays, corresponding to the

four different successive products which break up with the emission of a helium nucleus. If the products have reached equilibrium with the radium, as occurs within a month, there will be four alpha rays emitted for every radium atom that explodes. Similarly, the emanation separated from radium will reach equilibrium with its products within three hours, and will then give three alpha rays for each atom of emanation which explodes.

Use of Alpha Rays

While these explosions in which alpha rays are emitted are the most violent of the radioactive transformations and give about 93 per cent of all the energy that is lost by radiation, this energy can only rarely be used. These rays are effective in producing many chemical reactions, such as the formation of ozone from oxygen, or hydrochloric acid from hydrogen and chlorine, etc. But for this purpose the radiating substance must be exposed directly to the reacting substances. The walls of an ordinary container would absorb the alpha rays completely. It is possible to use the gaseous emanation in glass tubes so thin that the rays pass through, but the glass may be no thicker than a sheet of tissue paper. If the alpha rays from radium are to be used, the radium must be applied directly or through a very thin coat of varnish. Since the alpha ray of maximum range in air penetrates only 7 cms. of air, and the stopping power of a substance is roughly proportional to its density, and, finally, since the density of ordinary materials is about a thousand times the density of air, it follows that the rays cannot penetrate more than 0.007 cms., or less than a tenth of a millimeter of any solid or liquid. The penetration is, in fact, only a few hundredths of a millimeter. Only carefully designed "direct applicators" therefore allow the use of these rays.

Furthermore, the rays are of no value except in the treatment of very superficial growths, since they cannot penetrate into the tissues. Obviously, as in all chemical

reactions, the application of energy to a system has no effect unless that energy is absorbed by the system. A perfectly transparent substance can never be changed by light. So also if the deeper layers have no opportunity to absorb the alpha rays they can have no effect.

For these reasons we are not concerned as to the possibility of separating the three or four different species of alpha rays from each other. This can be done by interposing very fine screens which absorb the weaker rays and allow the faster ones to pass, but this has no practical purpose.

It is important, however, that the alpha rays can be thus easily absorbed and removed from the more useful beta and gamma rays. Indeed, care should be taken when the latter rays are used that all the alpha rays are absorbed, since they otherwise cause severe surface burns, being about ten times as effective where they do go than are all the other rays together.

The Beta Ray Disintegrations

It has been stated above that Radium A, which gives alpha rays and is reduced to half value in only three minutes, produces Radium B. Since the former is in the sixth group of the periodic system, the latter is in the fourth group, being analogous to lead, though it has an atomic weight of 214. This substance is also unstable. Its explosions, however, are of quite a different nature from those of the elements we have heretofore considered. It explodes rapidly, so that it is reduced to half value in slightly less than half an hour. But it does not emit alpha rays. All the characteristics of the previous elements are missing. In their stead we observe the emission of rays that are much more penetrating, but which have individually much less energy than have the alpha rays. It has been shown that instead of being positively charged, they are negative, and instead of being of atomic size they are several thousand times smaller. They are, in fact, electrons, and are iden-

tical with the atoms of electricity which constitute an electric current when they flow through a wire or through an air gap.

These electrons differ from all other known electrons in their tremendous velocity. Some of them are ejected from the atoms of Radium B at a velocity which is 99.8 per cent of the velocity of light; that is, more than 180,000 miles per second. To give an electron such a velocity in air requires a potential of several hundred thousand or even a million volts. This fact alone indicates that these electrons, or beta rays, do not come from the surface of the atom, but from its nucleus, where the forces are condensed and sufficiently intense to account for these high velocities.

Another fact which indicates that the beta rays come from the interior rather than from the surface of the atom, is the change in chemical properties which ensues. Radium B has a valence of four, hence has four surface electrons. If it were one of these that was ejected, the valence should become three. As a matter of fact, the product of this explosion, known as Radium C, has a valence of five, and is chemically analogous to bismuth. This is explicable only on the assumption that the beta ray has come from the nucleus, that this therefore acquired an additional positive charge, and that this must be neutralized on the surface of the atom by the acquisition of a stray electron. One of the myriad electrons which are wandering everywhere throughout matter, is appropriated and becomes bound in the surface of the Radium C atom as a valence electron, giving to Radium C a valence of five, where Radium B had but four.

While the amount of energy carried by each one of these beta rays is less than one per cent of the energy of the much larger alpha particle, its velocity is so high that it penerates considerable thicknesses of matter. They can be detected after passage through as much as a meter of air. They pass through as much as 3 centimeters of aluminum. This is due to their velocity and their small size, which allows them to pass through the majority of

atoms without encountering material resistance. As stated above, the aggregate space occupied by an atom is probably less filled with matter than is the space occupied by the solar system. Like meteors in the astronomical analogy, they can therefore pass through what we consider solid matter with relatively few collisions.

It was stated above that all alpha rays from any one element have the same velocity as determined by their range. This is not true of the beta rays. Their velocity is most easily determined by deflecting them from a straight line with a magnetic field. When this is done the beta rays from Radium B, for instance, are shown to vary widely in their velocities, and, what is more strange, there are no less than thirty definite groups of velocities, all from this one substance. It seems obvious that any two atoms of Radium B must explode in the same manner, and that these groups of rays are therefore due to the various adventures of the electrons in their passage out of their parent atoms. For practical purposes it is important simply to know that the velocity, and therefore the penetrating power, of these rays varies by tenfold.

The product of this disintegration, Radium C, though it has a valence of five and is chemically very different from its parent, Radium B, has the same atomic weight as the latter, 214. The loss of the electron or beta ray does not decrease its mass by an appreciable extent, although all the other properties change. This Radium C also emits beta rays of various velocities and forms a product, Radium C′, which has a valence of six and gives again alpha rays, as mentioned above.

The Gamma Rays

The emission of beta rays is invariably accompanied by the emission of gamma rays. These latter are radiations in the true sense, *i. e.*, they are not material particles, as are the first two classes mentioned, but are ether waves, similar to light and *x*-rays. They are distinguished from

x-rays only by being much shorter in wave-length. Visible light waves are between 0.0007 and 0.0004 mms. in length, or in the more usual units, between 7000 and 4000 Angstrom units. As the wave-length of light decreases all matter becomes more opaque to it until at about 1300 A. U. all solids are entirely opaque. Much shorter wave-lengths, however, again penetrate, and when we reach a length of only one A. U. we have x-rays with their extremely great penetration. The shorter the wave-length the more penetrating an x-ray is. Hence the gamma rays, which are in fact x-rays with a wave-length of about 0.1 A. U., are the most penetrating of all known rays.

They are generated in the radium just as x-rays are generated in a tube. In the latter case a stream of electrons is projected through an evacuated space under a high potential, and thus strikes the material of the anticathode or target at a high velocity. The energy of the collision is radiated largely in the form of short-wave radiation or x-rays. The intensity of the x-ray emission depends only on the number of electrons passing, *i. e.*, on the milliamperage. The wave-length of the x-rays, however, depends on the velocity of the electrons, *i. e.*, on the potential or the spark-gap. The higher the potential the greater the frequency and the less the wave-length of the x-rays. It is of course well known that increase of potential gives "harder", *i. e.*, more penetrating and thus shorter wave-length x-rays. The conditions within the radium tube are the same. Atoms of Radium B and of Radium C are constantly exploding and sending out the electrons in the form of beta rays. These collide with the atoms of the various types of radioactive elements present in the tube and the energy of the collision is similarly radiated in very short waves. But since the energy with which the electron is sent out is much higher than from any potential obtainable in an x-ray tube, the rays thus generated have a correspondingly shorter wave-length. The extremely penetrating gamma rays from Radium B correspond to a potential of 200,000 volts and

presumably it is an intra-atomic field of about this strength that projects the beta ray electron.

As stated above, the beta rays from Radium B fall into some thirty different groups of velocities, and thus there are also many groups of wave-lengths in the gamma ray spectrum of this substance. In addition Radium C is present in every radium tube and contributes its own types of gamma rays. Finally, since the velocities of the beta rays are continuously reduced before they finally emerge from the tube, there is also a general distribution of gamma ray wave-lengths, a continuous spectrum.

While the potentials within the radioactive atoms are higher than those conveniently attainable in *x*-ray work and the gamma rays are thus more penetrating than *x*-rays, the intensities of the latter can be made much the greater. The intensity of such radiation is proportional to the number of electron collisions, and thus can be increased at will to very high values in *x*-ray tubes, while any one radium tube gives a constant intensity dependent only on the amount of Radium B and C it contains.

The Use of Beta and Gamma Rays

Both these rays may be used in therapy, but the beta rays can never be used without the gamma. Since the latter are so much more penetrating they cannot be separated from the beta rays by fractional absorption, and since they are light waves they cannot be deflected or removed by other means. Beta ray treatments must therefore count on the presence of the more penetrating though less powerful gamma rays. The energy of the gamma rays is only about one per cent of that of the beta rays. For beta ray treatment the radium tube must be used almost bare, *i. e.*, it must not be inclosed in lead. Two millimeters of lead will completely absorb the beta rays and two millimeters of aluminum will absorb ninety per cent of them. A bare tube will give a beta ray penetration of five to ten millimeters in tissue.

This penetration is so low that the gamma rays are

much more useful. For effective use without danger of surface burns the tube is covered with a layer of lead to absorb the beta rays. Since gamma rays are more penetrating than *x*-rays the question of their effective range is only one of intensity. Their energy per square centimeter of course decreases with the square of the distance from the tube, as with all other radiations, and hence to reach deep regions it is often necessary to use "cross fire" methods such that the spot aimed at receives repeated doses from various angles, while surrounding tissues are radiated only once from some one of the points of application. When a tube is inserted in a body cavity and the rays are to be used in one direction only, the back of the tube must be covered with heavier lead to prevent the escape of intense radiation. While even a centimeter of lead does not absorb the gamma rays completely, their intensity may thus be cut down to a point below that of effective dosage.

The ability to apply the tube directly to the surface of the lesion in this manner is of course one of the advantages of radium therapy. Because of the inverse square of the distance law, however, in such usage the intensity and therefore the effectiveness of the rays dies off rapidly. When the tube is at some distance from the lesion this is not true, and a uniform dose may be given to a large area. It should be noted that this law of decrease holds only for light radiations and is not exactly applicable to the material rays like the beta.

One more point should be mentioned. There is a close relation between the electrons which cause *x*- and gamma rays and those rays. The reverse process is equally common. Thus the passage of either *x*- or gamma rays through matter liberates large numbers of electrons. In the case of the very high frequency gamma rays these liberated electrons themselves attain high velocities, and are, in fact, beta rays. This is also true of the *x*-rays, although the frequency of the ray is less and the velocity of the liberated electron is less also. Furthermore, the *x*-ray tube is com-

monly at some distance from the point under treatment, so that these secondary electrons are dissipated. With a radium tube, however, they may be liberated at the very surface of the lead covering which excludes the primary beta rays, and may thus cause a surface burn in spite of heavy lead protection. For this reason the lead tube should be placed within a thin rubber tube. This will absorb the secondary beta rays from the lead and will itself emit very few electrons under the action of the gamma rays.

The chemical and therefore the therapeutic action of the beta and gamma rays is much the same, and they may be used interchangeably when their penetration and energy are borne in mind. The mechanism of this action will be discussed in a later paper.

It will be noted that the beta and gamma rays are evolved exclusively by Radium B and Radium C and not by the radium itself. These beta radiators are themselves products of the radium emanation, a fact which has led to the wide use of the emanation itself in place of radium tubes. This has many advantages, which will be dealt with in the second paper of this series.

RADIUMTHERAPY OF THYROID*

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In dealing with this subject we shall limit our discussion to the vascular variety of thyroid disease. We have had no experience in treating goiter of the hypothyroid form with radium, in fact, this being a non-functioning form it would seem that any process that would interfere with the blood supply of the gland would be injurious and perhaps accentuate the existing condition. We have treated 31 cases of exophthalmic goiter of varying degrees of severity, the first case being treated in September, 1917. The age of the patients varied from 74 to 16 years. Only two of the patients were young. One as stated 16, the other 19. These were both cases with pronounced exophthalmic symptoms and were not physiological goiters at all. It is known to all of you that the tunica intima of the blood vessels is exceedingly susceptible to the radium ray eventuating in an obliterative endarteritis, also it is well known that a new cell or diseased cell is usually many times more sensitive to radium than an adult cell. Working on these two premises it would seem natural that a growth of great vascularity and containing new growth cells should give reaction if treated with radium. Attempt has been made to ligate more or less of the thyroid arteries to starve the gland into subjection. Surgical attempts have removed a portion of the gland but the former process, of these two, only attacks the blood supply, not the degenerative cells, and the latter process while removing parenchymatous tissue along with the diseased part certainly left behind diseased tissue in the remaining portion, and the blood supply to this part more or

*Read before Western Roentgen Society, December, 1919.

less undisturbed. It is consequently only a question of time for there to be further degeneration and more toxic substances poured into the blood streams with further reduction of the normal functioning tissues of the gland. Of the 31 cases that we have treated with radium, six had already been operated with recurrence of symptoms as bad or worse than before. We have had to ray five cases the second time as the dosage was probably inadequate. One patient has taken up Christian Science, apparently not benefitted by the treatment; two with very bad broken compensation of the heart have died since treatment from acute dilatation, one 3 months after treatment, the other 5½ months, though in both cases the pulse had been slowed an average of thirty beats and the nervous symptoms were considerably reduced. In one case out of five there has been no reduction of the goiter. The others have diminished from ¾ of an inch to 3¼ inches in circumference. One woman patient, age 35, was burnt, the burn healing in twenty-four days and leaving a white scar the size of a nickel on her neck. Her goiter also did not go down until thirteen months had elapsed and suddenly the neck circumference diminished 1⅝ inches in a space less than two months. There has been symptomatic cure in all of these cases with the exceptions noted. The pulse beat has usually been reduced twenty to fifty beats, the nervous symptoms and tremor have vanished; exopthalmos has become less marked or disappeared entirely; patients have gained in weight and general well being. Certainly how permanent this will be we do not yet know, as our first case dates back only about twenty-seven months and thirteen cases have been treated during this present year.

At the risk of being somewhat tedious, we shall describe in detail the technic employed, having observed that the articles written and published appertaining to radium treatment contain a vast amount of information as to what is being done but with practically no information as to how the man did it, and that would seem to be quite essential, if

it be published with a desire to be helpful. We first rayed goiters in this manner. We divided the neck area into rectangles 1½x¾ of an inch dimension. We placed upon each square a radium tube containing 25 milligrams of radium element screened with a ½ millimeter of silver, one millimeter of brass and two millimeters of para rubber and left in situ for two hours. The whole goiter was covered in this manner. We found that there was considerable hyperemia of the skin, a few cases taking on a bluish appearance apparently suggestive of a burn though this did not take place. The action on the goiter was effective but it seemed that too much action was wasted upon the skin, so we manufactured a lead cone open at the bottom and the top, the sides composed of lead 3 millimeters in thickness—the bottom of the cone 2¼ inches square, the top 1 inch. Two thicknesses of rubber glove were placed over the bottom of the cone; it was then stuffed with cotton until an altitude of 1 inch was attained and then 100 milligrams of radium element placed upon this, using ½ millimeter of platinum and 1 millimeter of lead and the top then covered with cotton, lead and adhesive plaster. The average neck can be treated with two applications of the cone. A line is drawn down the center of the neck, other lines on each side of this ¼ of an inch away and then a square is marked out with indelible pencil so that when the cone is placed upon the tumor the lines are just visible all around. In some of the larger goiters it has been necessary to map out three squares, one over the isthmus and one over each lobe. The cone is strapped in place with adhesive plaster and usually left for six hours on each square. In a few of the more exaggerated conditions we have increased this exposure up to twelve hours and we have noted that there is scarcely a reddening of the skin but there seems to be most efficient action given by the gamma ray upon the thyroid tissue. Usually these patients seem a little worse for the first few days or week due to some edema of the gland bnt after abont two weeks, improvement begins and at the end of a month the improvement is decided.

We would simply say in closing, that eleven cases in our series of thirty-one had been declined as operable risks by some of the best surgeons in the country and that these patients, several of them wives, sisters and aunts of physicians are now enjoying good health and attending to their regular duties.

25 E. Washington St.

THE ELEMENTARY PHYSICAL CHEMISTRY OF THE DEVELOPMENT OF *X*-RAY FILMS AND PLATES

Millard B. Hodgson
Rochester, N. Y.

THE EMULSION

A photographic plate consists essentially of a sensitive emulsion coated on glass. This emulsion is, of course, coated while in a liquid state and dried down in a layer which is about one-thousandth of an inch thick in the average *x*-ray plate or film.

Fundamentally the emulsion consists of a suspension of silver bromide in gelatine. It is prepared by adding together in a gelatine solution silver nitrate and potassium bromide in proper proportions, the essential reaction being that the silver unites with the bromine to form silver bromide. Were this reaction to take place in a strictly liquid solution, the silver bromide crystals formed would sink to the bottom, forming a white precipitate. In the gelatinous solution, however, they remain in suspension and form, after coating, the sensitive units of the photographic plate or film.

THE PHYSICS OF EXPOSURE AND DEVELOPMENT

Silver bromide, as found in the photographic emulsion, occurs in the form of more or less perfect crystals belonging to the cubic system. In the average plate they are usually in the form of thin, fragmentary slabs of various shapes, a great many of them being triangular. Some of these formations are shown in Fig. 1, which is a micrograph made at a magnification of about 1,000 diameters. These silver bromide crystals in the finished photographic plate are sensitive to light. They are also sensitive to

x-rays and other forms of energy, whether applied in the form of heat, friction or chemical change. They are "sensitive" in the sense that they will record the relative amount of action on them by any of these agencies. The reaction which occurs in a silver bromide crystal when exposed to light or x-rays, however, is so small that it cannot be measured by any direct physical or chemical means. By treating exposed emulsion, however, with solutions called "developers", the bromine is removed from the grains affected by exposure, leaving metallic silver. Reduction of each grain is a steady transition from silver bromide to silver, the bromine being taken up by the developer. The grains not affected by the exposure, and hence undeveloped, are then dissolved in a suitable solution. Changes occurring in the development of silver bromide grains are shown in Fig. 2.

It has been found that a crystal which has been exposed to light so that it becomes developable is entirely developable, provided sufficient time is given for the action of the solution. This can be seen by inspection of the micrograph in Fig. 3, which shows a single grain at two stages of its development.

The silver grains of the visible image in the negative are thus formed in practically the same space occupied by the parent crystals. This is illustrated in Fig 4, which is a micrograph of the *same* grains, before and after development. During development the reduced silver is deposited in ultramicroscopic particles, so that the completed grain appears like a collection of black soot embedded in the gelatine. When this phenomenon is watched under the microscope the transition seems very similar to the popping of a kernel of corn, for in most cases the shape of the original crystal is somewhat distorted.

THE LATENT IMAGE

The reaction which takes place when light strikes the silver bromide crystal is generally termed "the formation

of the latent image'', and there are numerous theories which seek to explain the nature of the change. Mees[1] gives figures on the approximate amount of energy involved in forming a latent image in a high speed photographic plate, and deduces from these computations that the energy involved in making a silver bromide crystal developable is of the order of that involved in the liberation of an electron from one molecule of silver bromide. It is, of course, too small to measure by any known direct laboratory methods.

THE DEVELOPER

The development of the latent image in a photographic plate is a complex chemical reaction; for in addition to the delicate materials in the plate itself, there enters into the reaction four other distinct compounds, each in solution. Considering then, that there are seven primary substances entering into the process of development, from which there are formed additional compounds, one can easily see the necessity of confining the possible reactions to a minimum by the use of standard materials and standard methods.

Broadly speaking, a developer consists of four essential constituents, as follows:

(1) A ''reducer''
(2) A preservative
(3) An accelerator
(4) A fog restrainer

The reducer is usually an organic chemical like Elon or Hydrochinon or Pyro. Without it, the solution would not develop the image. Being a reducer, it follows that it is useful in the developer only so long as its ability to take up oxygen is retained. It, therefore, follows that useless oxidation of the reducer by exposure of the developer to air should be guarded against.

It is the function of the preservative to keep the useless oxidation of the reducer to a minimum. For this work

[1] C. E. K. Mees—*Journal of the American Chemical Society*, November, 1913.

sodium sulphite is by far the most widely satisfactory chemical. If, however, only these two materials were put into a developer, the solution would take an infinitely long time to act. To accelerate this process it is necessary that the solution be alkaline. Sodium carbonate is quite satisfactory for this, and in addition is cheap and easy to secure.

But these three materials in one solution, while they would cause the development of those grains which were exposed, would, if allowed to act for the time necessary to develop the image, also cause the development of other grains which were not exposed. It is to check this tendency that the restrainer must be added. The function of this restrainer, which is usually potassium bromide, is to stop the development of fog, or those grains which are in such a state that the slightest action of the developing solution will start their reduction.

It is necessary, of course, in a solution designed for development, that the amounts of these constituents must be properly balanced in their relations to one another. There must be just sufficient quantity of reducer to perform the work necessary, sufficient sulphite to preserve this amount of reducing agent while not in use, a minimum of carbonate to make the reaction time normal and a minimum quantity of restrainer that will prevent a reduction of grains which have not been intentionally exposed.

After the reaction of development is complete the plate should be rinsed carefully before proceeding to the operation of fixing, in order to remove developer held in the gelatine. At this stage the plate still contains, in addition to to the developed silver image, the balance of the silver bromide which has been unaffected by exposure. Being opaque, it must be removed.

THE FIXING BATH

The fixing bath, too, is a combination of chemicals in solution which is somewhat analogous to the developer. The fundamental material entering into it is "Hypo" or

sodium thiosulphate—which, in solution, is a solvent for silver bromide. Unfortunately, in combination with developer which may be left after rinsing, it will cause the deposition of colloidal silver. This is the familiar "dichroic fog", which appears as a red stain by transmitted light and as a green one by reflected light. It is necessary, therefore, to add to the fixing bath a chemical which will counteract this possible action or "kill" the developer. Acetic acid has been found to perform this function quite satisfactorily.

In the fixing bath, as well as developer, it is also necessary to add sodium sulphate as a preservative, not only for the Hypo itself, to prevent its being acted upon by the other materials in this solution, but to prevent the oxidation of developer carried over into the fixing bath before it is "killed" by the acetic acid.

Finally, there is usually added a hardening agent which will tend to toughen the gelatine so it will stand a thorough washing in water of average temperature. This hardening agent is, in most cases, an alum. White potassium alum has been found most satisfactory.

DRYING

It should be remembered that the making of a photographic negative is not completed until the developed emulsion is dried, for unless this seemingly simple operation is correctly carried out the care in the previous operations may all be in vain.

During the drying of a photographic emulsion on glass or other solid support there is a gradual contraction of the gelatine vertically in the direction of the support until it is, when dry, scarcely one-twentieth of its wet thickness. This, of course, results in a series of strain adjustments, which must proceed at a uniform rate if the original image is not to be distorted. The drying of all negatives, therefore, should proceed at a uniform rate — in an atmosphere where there is no likelihood of contamination.

In all operations — exposure or formation of the latent image, development, fixation and drying — the routine methods should be standardized to preclude the introduction of disturbing factors.

The writer wishes to acknowledge his indebtedness to Mr. A. P. H. Trivelli for the interesting micrograph shown in Figure 4.

Research Laboratory
Eastman Kodak Co.
June 1919

Figure 1

Figure 2

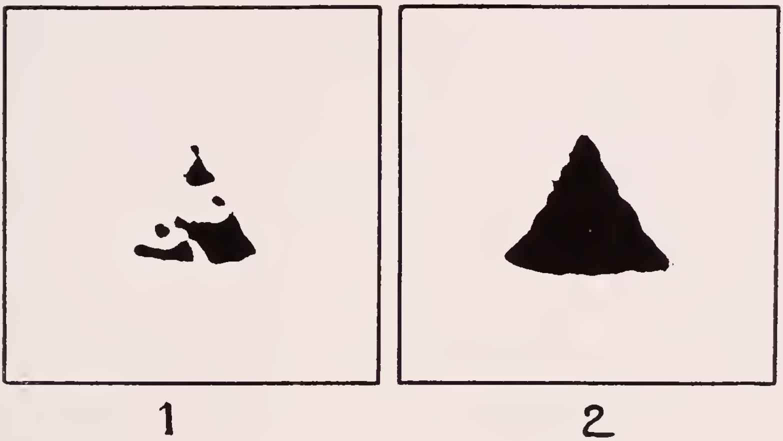

Figure 3

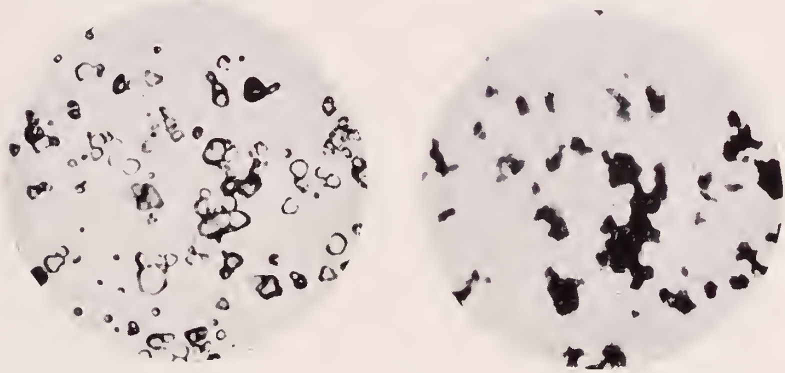

Figure 4

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PUBLISHED EVERY MONTH AT IOWA CITY, IOWA

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ORGANIZATION

All societies with large membership rolls of wide geographic distribution must be managed by a council. This council may be composed of a definite group elected by the membershiy at large or it may be by executive officers and certain committees, who assume the management and thereby comprise the council. The progressive tendencies, the democratic spirit and the standards of professional dignity of an organization are for the most part dependent upon the character of those constituting this council.

If a council consists of but a few men, similarly situated and located, a membership of wide geographic distribution, the organization is handicapped. It is stifling the best purposes of an organization to continue to provide a small coterie of men, year after year to direct the policies of an organization regardless of the fact that their scentific and professional qualifications are unquestionably incontestable.

It is obvious that a time limit must close one's activity in a council of this character in order that his place may be filled with younger blood which carries enthusiasm as its main attribute.

Enthusiasm and energy are coupled inseparably with youth and are always found to diminish with the declining years past middle age. From the knowledge and experience gained during the ambitious periods of juniority comes the wisdom and dignity of seniority, and it is to this very necessary class that the managing body or council of any organization must look for wise counsel and conservatism.

The Western Roentgen Society, founded late in 1915 by Roentgenologists of the central United States, was given at its very birth these principles along with other features of successful organization. The governing body or council consists of the executive officers, elected in open meeting each year, a board of counselors, selected by the president,

to represent his policies in such states or districts as he may designate, and two standing committees. In each of the committees one member is retired each year. The vacancies in these committees are filled one by election and the other by the retiring president. It may be observed that the senior division of the council may be represented by these committees. The executive officers and board of counselors represent the active and more aggressive or junior division of the council. In this manner the derogatory influence of continuous centralized control is adverted and a full supply of new blood is constantly secured.

Under such a regime the rapidity in growth in this Society has been almost phenomenal. As it closes its fifth annual session it is undoubtedly the largest Radiological society in America if not in the world.

The growth in number of radiological societies in the United States within the past few years, seems remarkable. It is unquestionably an expression of a rapidly growing science. For some fifteen years, workers in this line were satisfied with but a single organization, but within the past five years or so many organizations have come into existence. The four natural divisions of the United States are at present supplied by four well organized societies, *i. e.* the Eastern, Central, Pacific Coast and Southern divisions. In addition to these more or less general societies there are many very well organized local societies. For example, the Philadelphia, Omaha, Kansas City, Chicago, and New York Roentgen Societies. Several state societies have organized a roentgen division within the past few years.

In the Journal of Roentgenology attention has frequently been directed to the growing demands for one large radiological association, truly democratic and national in character, combining all the virtues made possible only by quantity as well as quality of membership, with a section in the American Mediical Association and a powerful influence generally to the glory of the medical profession.

Abstracts

HARRY WESSLER, M. D., and CHARLES M. GREEN, M. D. Intrathoracic Hodgkins Disease: Its Roentgen Diagnosis. *The Journal of the American Medical Association*, Vol. 74, No. 7, February 14, 1920.

Hodgkins disease at times presents clinical irregularities which make diagnosis difficult. To determine the value of radiographic examination in this disease, the authors investigated the chests of 25 cases of Hodgkins disease and described the following types: (1) The mediastinal tumor type. (2) The infiltrative type. (3) Isolated nodules or metastases in the lung. (4) Discrete nodes at the roots of the lungs.

Paratracheal nodes appear on the plate as an oval shadow situated to the right side of the trachea, in the upper mediastinum and below the sternal end of the clavicle. The frequency of involvement of these nodes in Hodgkin's disease and its rarity in other diseases may be of value in the diagnosis of obscure cases.

Among other conclusions the authors state that although the roentgenogram in some cases presents nothing characteristic, in a considerable number a distinction from other forms of new growth or glandular enlargement can be made. The article is adequately illustrated.

H. H. JAMWAY, M. D., New York City. Treatment of Cancer, Particularly of the Tongue, Tonsil and Rectum, by Buried Emanations. *The American Journal of Roentgenology*, February, 1920.

The direct application of radium to cancer has been used for a number of years in the Memorial Hospital. For the past year and a half it has been used only in selected cases.

A more perfect method is now in use, that of the use of radium emanations. These emanations are sealed in glass tubes and embedded within the tumor tissue.

The radium emanation is collected in a long capillary tube which is divided into minute parts by a flame, sealing the ends. These tubes are three mm. by one-fourth mm. These tubes are placed in hollow needles, no larger than an aspirating needle. Then by a wire stylet these tubes are placed evenly throughout the tumor mass.

The advantages of this method are:

1. There is very little loss of radiation, inasmuch as the emanation is inserted within the tumor tissue and left there either permanently or until it sloughs out and almost one hundred per cent of its efficiency is directed against the tumor.

2. It is economical as small quantities will produce results that other methods will only by large quantities.

3. Both the beta and gamma rays are used in them entirely, filters not being used. Thus the full effect is utilized.

4. A more intense radiation of the growth can be secured with greater safety and less discomfort to the patient because the surrounding tissue is not damaged.

5. The simplicity of the method makes it not only the easiest method but furnishes a means of treatment for tumors inaccessible to other means. For instance: Tonsils, Sinus and Rectum. These claims have been substantiated in practice and are illustrated by a variety of cases.

The method is not entirely devoid of danger. Two patients with suppurating growths died of sepsis, a number of hemorrhage. However, the chance of life is far greater than by any other method. The old and feeble are susceptible to sepsis. Hemorrhage when seen to be impending can be prevented by ligation. E. W. Rowe.

Henry K. Pancoast, M. D., Philadelphia. The Roentgen Ray in Cancer of the Uterus. *American Journal of Roentgenology,* 1920, Vol. VII, No. 3, pp. 146, 147.

In the treatment of all forms of malignancy by either, or both, radium and roentgen ray the primary growth must be carefully studied as well as the manner of metastasis and the places it is liable to occur. An inoperable malignant growth is easily excited to metastasis. Care must be taken not to stir up activity.

Uterine cancer should not be treated by roentgen ray alone. The roentgen ray should be used to supplement surgical or radium treatment. Cancer starting in the cervix should be treated with radium first. If metastasis has occurred the roentgen ray should be employed also.

The maximum dose of radium is generally employed. At the best its effects are exerted within a radius of only a few centimeters. The roentgen ray must be employed if it is necessary to go beyond these few centimeters.

Unless roentgen ray treatment is carried out scientifically it is worse than useless for it will cause cell proliferation in insufficient quantities. All paths and metastatic growths must be treated with sufficient dosage to cause death of the cancer cells.

To give lethal doses at increasing depths many portals of entrance must be used. The use of radium needles and emanation tubes around the periphery as well as radium in the cervix is yielding as good results as is possible. In the use of radium statistics are improving. E. W. Rowe.

M. William Clift, M. D. Fluoroscopic Examinations in Injuries of the Head. *The American Journal of Roentgenology,* 1920, Vol. VII, No. 3, pp. 136–142.

The experience of the war has demonstrated the value of fluoroscopic examination of the head for fractures, foreign bodies, and sinus infections.

Civil practice since the war has demonstrated the practical value. Fluoroscopy is an additional aid to roentgenographic methods, not a substitute. It may aid to secure a good position that differs from a standard position.

The army small radiator type of Coolidge tube gives clear

images. A spark gap of five inches, milliamperes three to five, and a properly prepared retina are the requisites.

Cranium: The head is placed in the dorsal position and rotated to a lateral in both directions while under observation.

Sinuses: The frontals and anterior ethmoids are examined in the anterior posterior position. The maxillary sinus in the Waters position.

Fluid (pus or blood) or foreign bodies are easily determined.

Jaw: In the dorsal prone position slight variations of the mandible give satisfactory views of the jaw.

Eye: The injured eyes are turned toward the screen until the silhouette of the lids are seen. The eye ball is watched during rotation, while the head is held still. This enables one to see if the foreign body is in the globe or outside.

Foreign Bodies: The following points may be determined:

1. Penetration of the skull. Extent and nature of the fracture.
2. Penetration of the dura as evidenced by the presence of fragments or foreign body.
3. The presence of a foreign body:
   a. Size.
   b. Location.
   c. Depth.

Foreign bodies in the brain pursue a fairly straight course. So that the principal ray passing through the foreign body and point of entrance will pass through the fistula or tract.

Operative Guides: For the jaw and neck the intermittent control method of Ledoux-Lebard is of great importance.

For a surgical guide the Hirtz compass is accurate and with experience rapid with the fluoroscopic technique. The electro-magnet used by the method of M. Henri Béclere is of more value to the surgeon because extraction is preferable to mere localization. If these methods are combined, a

bronchoscope used in the place of the central rod, the forceps can be passed down with a minimum of trauma.

E. W. Rowe.

H. H. Hazen, M. D., and F. J. Eichenlaub, M. D. The Roentgen-Ray Treatment of Verruca Plantaris. *Journal of the American Medical Association*, 1920, p. 1311.

The literature gives a few instances of the use of the roentgen-ray in the treatment of this disease.

One of the authors is a professor of Dermatology and Syphilology in Georgetown University School of Medicine, and Howard University School of Medicine; and the other is an instructor in the same school, where they have had ample opportunity to watch their cases.

Records of sixteen private cases treated by roentgen ray are at hand. The technic is one and one-third Holzknecht unit every three to four weeks. All but one were cured. That one was particularly resistant, being the flat wart of known stubbornness to treatment.

There was one recurrence where a patient discontinued treatments. The number of treatments varied from one to seven. The average was three. The cases seem permanent. Some of the cases have been followed six years. All other forms of treatment for this disease have been abandoned.

E. W. Rowe.

E. H. Weld. The Toxicity of Pyellographic Media. Report of death following the use of Thorium Nitrite. *Journal of Urology*, 1919, Vol. III, p. 415.

Following the death of a patient after the use of thorium nitrite the author carried out a number of experiments to determine the relative degree of toxicity of sodium bromide, potassium iodide, and thorium nitrite.

A twenty-five per cent solution of sodium bromide, a twenty-five per cent solution of potassium iodide, and a fifteen per cent solution of thorium nitrite were injected into the veins of dogs. The sodium bromide even in quantities

of fifty-five c.c. caused no effect. Two or three c.c. of the potassium iodide solution caused death. Sodium iodide when given in quantities as high as fifty c.c. caused a moderate reaction from which the animal soon recovered. The thorium nitrite caused death in all but one dog and that was a fresher solution than the others.

Deductions:

1. The potassium radicle is dangerous. Potassium iodide should be used with great care.
2. Thorium nitrite is toxic to the heart muscle. The older the solution the more toxic it becomes.
3. Sodium bromide is non-toxic, cheap, easily prepared, readily accessible, not irritating, and the best media brought forward. It should be chemically pure and may be sterilized by boiling.

For pyelography a twenty per cent solution is sufficient. For cystography a ten per cent solution is sufficient.

E. W. Rowe.

C. Thurston Holland. War Lessons for Radiology. *The British Medical Journal*, March 13, 1920, pp. 253–255.

When the war broke out in 1914 the British had no roentgen equipment nor trained specialists in roentgenology. The army was devoid of a conception of the importance of the roentgen ray in war surgery. The permanent staff of officers failed to grasp the situation. The younger surgeons from civil practice knew the importance of such a department. The older men were hostile. Equipment that was available was inadequate and antiquated. Trained specialists called from busy practices to take up war work were detailed to minor positions, often they were given only orderly duties. Technicians were placed in the roentgen departments, often these were students with little or no training—few of them with any medical training. The surgeons made their own interpretations and controlled the situation everywhere. They openly were hostile to any recognition of expert roentgenologist and reported all was well

even when the service was deplorable and insufficient. The eminent surgeons meeting in the War Office had never had associated with them one expert on roentgen matters.

Later conditions changed. Experts were added to the different commands. Sir John Goodwin, Sir Berkeley Moynihan, Sir Harold Stiles and Sir Robert Stiles are especially to be thanked for their efforts to assist in developing the roentgen department. But the real organization of the department came too late to be of any material assistance.

In answer to the question, "What has been the effect on the production of *x*-ray apparatus, on the invention of new instruments?", he says that the only outstanding contribution has been the American Standard Mobile Unit and the radiator type of Coolidge tube. In the later months of the war these units and supplies were turned out in fairly adequate numbers. English-made equipment, especially tubes, has not been as serviceable as some foreign makes. (American?)

"What has been the effect of the war on *x*-ray workers and *x*-ray works?"

Those experienced in the roentgen work have been taught very little by the war. Localization was highly developed and bone injuries were more carefully studied. Diaphragmatic hernias were frequently recognized and made recognizable by the roentgen ray. Gas gangrene was early recognized. Tropical abscesses were frequently seen. In therapeutic work the treatment of keloids by radium and roentgen ray has been advanced.

The great effects of the war on x-ray work: Roentgenology was brought into prominence. Enormous numbers of laymen were educated to its use. The whole medical profession were impressed with its use. The older men and those in general practice knew little of its use in disease of the thorax, kidneys and gastro-intestines. A large number of men have learned well to use and coöperate with the roentgenologists.

Dangers:

A large number of males and females have a smattering of roentgen knowledge. These technicians may be a menace to good work.

All thinking of following roentgenology as a specialty should take a special college course even if they have had war experience.

E. W. Rowe.

The

JOURNAL *of* RADIOLOGY

Published by the Radiological Society of North America

VOLUME I | March, 1920 | NUMBER 3

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JOSEPH COLT BLOODGOOD, Baltimore, Md.

Editorial 239

THE DIAGNOSIS AND TREATMENT OF BENIGN AND MALIGNANT TUMORS OF BONE*

JOSEPH COLT BLOODGOOD
Baltimore

Utimate Results. This personal study of 240 cases of bone tumors observed over a period of about twenty-seven years, brings out the fact that the probabilities of a permanent cure, even after high amputation, for the true periosteal and central sarcoma of bone is so small that, when one is confronted with a bone lesion, one should not perform any radical operation until every possible means of diagnosis has been employed. The burden of proof is to demonstrate that the lesion is malignant.

Results in Periosteal Sarcoma. Up to the present time there are but two cures (less than 4 per cent.) among the cases followed. These may be summarized as follows:

Total of cases	70
Cured 5 years	2
Lived 3 years	1
Lived 2 years	3
Lived 1 year	6
Lived less than 1 year	36
Postoperative deaths	3
Lost track of	18
Dead of other causes	1

This demonstrates that the average duration of life in a periosteal sarcoma is one year or less—42 out of 52 cases followed. The cause of death in periosteal sarcoma is metastasis to the lung, and not local recurrence.

Metastasis to the Lung in Periosteal Sarcoma. The ob-

*Paper read before the Omaha Roentgenological Society, March 27, 1920, at Omaha, Nebraska. Illustrations by Mr. Herman Schapiro.

servation in which this has taken place in the shortest period after the first symptoms of the local growth has just been brought to my attention by Dr. H. H. Donaldson of Pittsburg, Pa.

The patient is a white female, aged ten years; the symptoms had been present but four weeks (pain four weeks; swelling one week) before the patient came under observation, and an *x*-ray demonstrated a periosteal sarcoma of the shaft of the femur extending from condyle to within 2 inches of the greater trochanter. About two weeks later (six weeks after the onset) an *x*-ray of the chest showed extensive metastasis to the lung.

A second case was brought to my attention in Omaha by Dr. R. L. Smith in which the *x*-ray of the chest within a few months after the first symptoms showed extensive metastasis. Pathol. No. 25888. (Figs. 87 and 88.)

In every bone tumor, therefore, *an x-ray of the chest* should be a routine procedure, but in a number of cases under my observation, in periosteal sarcoma, the picture of the chest at the time of operation was negative, and metastasis to the lung was not observed until later—in one case not until two years after operation. This must be looked upon as evidence that metastasis was present, but not evident, in the x-ray picture.

Cured Cases of Periosteal Sarcoma. Two cases—less than 4 per cent.

Pathol. No. 14143 (ix). Patient of Dr. Twinch of Newark, N. J. White female, aged 11 years; swelling of upper third of tibia 6 weeks; *x*-ray—periosteal sarcoma of upper third of tibia with much new periosteal bone formation and very little bone destruction. First operation—excision of piece for diagnosis by Dr. Twinch; microscopic diagnosis (Bloodgood): Mixed spindle-and-round-cell sarcoma, with numerous giant mononuclear cells and many giant cells of the giant-cell tumor, or epulis type. Amputation advised and performed in 1913. The patient is well (1920) seven years since operation.

There is apparently no question in this case that the tumor belonged to the most malignant type of sarcoma. We find the giant mononuclear cells only in the very malignant sarcomas, in 21 cases: 14 periosteal and 7 central.

The presence of giant cells (of the giant-cell tumor, or epulis type) in periosteal and central sarcoma apparently does not affect the prognosis. I have noted them in 15 cases: 5 periosteal and 10 central.

Pathol. No. 14392. (ix) Amputation of upper femur by Dr. Follis, Johns Hopkins Hospital in 1913. Patient well September, 1919, six years and two months. White female aged twenty-four. Pain and swelling above knee one year and six months. Clinical picture and *x*-ray typical of a periosteal sarcoma. The gross specimen shows that the lower half of the femur is surrounded by a periosteal tumor with a pathological fracture at the epiphysis. Microscopically, it is a small-round-cell sarcoma.

I have observed 9 cases of small-round-cell sarcoma. All of them were periosteal lesions. This is the only cured case.

There is nothing in these two cases of periosteal sarcoma to distinguish them from the 50 cases in which the patients ultimately died of the disease. In the first case (Pathol. No. 14143) the patient was young (11 years), the amputation early after the symptom of onset (7 or 8 weeks), and in this case a piece had been excised for diagnosis. In the second case (Pathol. No. 14392) the patient was older (24 years), and the amputation 18 months after the symptom of onset. So it may be considered a late intervention. Neither of these cases had any other treatment, except amputation. Therefore we must look upon these cures as accidental, but they do establish the fact that now and then the most malignant periosteal sarcoma may remain a local lesion and such patients are cured by the removal of this lesion.

Results in Central Sarcoma. Up to the present time there are 2 five-year cures, which is about 10 per cent. of the total of followed cases (19). Of these two cures one is still living

(April, 1920) six years and ten months after amputation of the femur for a central sarcoma of the lower end of the femur of the malignant hemorrhagic cyst type. The second case is dead nine years after operation with recurrence in the chest wall and metastasis to the lungs.

The results may be summarized as follows:

Total of cases		25
Cured 5 years	2	
Lived 4 years	1	
Lived 2 years	2	
Lived 1 year	5	
Lived less than 1 year	8	
Postoperative death	1	19
Lost track of	2	
Recent, living	4	

As compared with periosteal sarcoma the central sarcoma shows a little better prognosis, and, on the whole, the duration of life is longer.

Among the 4 recent cases which are living and apparently free from recurrence, in two it is three years since the operation, but, as noted above, one patient lived this long without signs of recurrence and then died with metastasis to the lung about four years after the operation.

Later, when I differentiate the types of periosteal and central sarcomas I will bring out the fact that the central sarcoma of the malignant hemorrhagic cyst type (called *bone aneurism* in the older literature) has shown the best results—33 per cent cured five years among six cases, and two recent cases apparently well three years.

Cured Cases of Central Sarcoma. (Both Malignant Bone Cysts.) It is important to note here that for comparison I have considered a patient cured when five years after operation there were no signs of recurrence. Of four five-year cures of periosteal and central sarcoma three are living and apparently free from recurrence today, and one is dead nine years after operation. This demonstrates that late

recurrences, very unusual in sarcoma of bone, may take place.

Pathol. No. 10602. (XIII.) Fig. 26. Central sarcoma of the shaft of the humerus, of the malignant hemorrhagic-cystic type.

The patient was first observed by Drs. Finney and Fisher of Baltimore in 1910. White male, aged thirty. Pain after contusion of the arm two years ago. This pain has continued. Five months before Dr. Finney's operation, fracture at the junction of the middle and upper third of the humerus. The *x*-ray taken at this time shows the fracture, but the tumor was not noted. I had a recent opportunity to restudy this *x*-ray, and I find a definite central shadow at the site of the fracture, and am of the opinion that the fracture was a pathological one. About one month after this fracture swelling was observed, and the *x*-ray shows a more definite central area (Fig. 26). Operation August 23, 1910, by Dr. Finney,—curetting. October 10, 1910, second curetting. Then treatment by Dr. Coley of New York with serum. January, 1911, four months after the first curetting, amputation at shoulder-joint by Dr. Coley. Serum treatment continued. One year later, January, 1912, removal of a metastatic mass in the axilla. Serum treatment continued. Two months later, March, 1912, shoulder-girdle amputation by Dr. Fisher of Baltimore, because of recurrence. This patient remained well and free from recurrence to January, 1919, almost seven years after the last amputation and nine years after the first curetting. Then there was observed local recurrence in the scar of the axillary stump and metastasis to the lung.

I saw this patient on a number of occasions, and he was perfectly well and able to be active in mercantile life for a period of almost seven years.

When Dr. Finney curetted in 1910, as far as I can ascertain, the bony shell was intact except at the site of the pathological fracture. There was not much expansion of the bony shell. The cavity was filled with blood and soft,

friable, hemorrhagic tumor tissue, resembling in the gross the giant-cell tumor. When this tissue was received in the laboratory I was of the opinion that it was a giant-cell tumor. But the frozen sections showed no giant cells, but a mixed spindle-and-round-cell sarcoma. Microscopically, there was no question as to the malignancy of the tumor.

At that time, now almost ten years ago, Drs. Finney and Dr. Coley decided to try the serum before amputation. I was rather inclined to the conclusion that resection of the humerus with bone transplantation, or shoulder-joint amputation, promised the patient a better chance of an ultimate cure. The long duration of life in this case may be explained by the serum, but the patient's arm was not saved and it could have been amputated in August, 1910, instead of in January, 1911, four months later.

If this case came under observation today, we could conclude that his age (30 years) would exclude a bone cyst. Bone cysts (Fig. 27) are very common in the shaft of the humerus, but all the patients have been under twenty, usually under fifteen. Up to the present time we have never observed a giant-cell tumor in the humerus as a central lesion. Therefore, one would have explored. Finding the blood after the removal of a piece of the bony shell, would have at once suggested the malignant bone cyst, and in this case the frozen section would have been easy to interpret, because of the absence of giant cells of the giant-cell tumor type. One, then, would have resected the humerus with its periosteum, giving the lesion a wide margin and transplanted into the defect a piece of the fibula.

There is nothing in this *x*-ray (Fig. 26), as we look at it today, to allow a differential diagnosis between a bone cyst, a giant-cell tumor, and a central sarcoma.

Pathol. No. 14229. (XIII) Figs. 20, 21. Amputation of the upper third of the femur in 1913. Patient well April, 1920, seven years. The tumor involved the lower end of the femur and condyle. It belonged to the type of the malignant hemorrhagic bone cyst. Microscopically, it was

a large spindle-and-round-cell sarcoma, with giant mononuclear cells and a few giant-cells of the giant-cell tumor type. That is, it resembled Pathol. No. 14143, a periosteal sarcoma of the upper third of the tibia, Dr. Twinch's case, which has remained well seven years after amputation.

This case of malignant hemorrhagic bone cyst (Heine) was a white female aged 61. For ten years she has had pain and tenderness in the left knee suggesting an arthritis, but no other joints were involved. There was no definite history of trauma. For two years there has been some flexion of the leg at the knee and partial fixation of the joint. As the patient was practically bedridden, there was no opportunity for a pathological fracture. This patient had been under the care of Drs. Baer, Baetjer and Penrose for one year. Their diagnosis had been chronic arthritis; treatment by fixation (plaster) was so painful that it had to be discontinued.

Dr. Penrose asked me to see this patient in 1913. The examination of the knee-joint suggested a chronic arthritis. No other joints were involved. The x-ray (Fig. 20) (14229) is a lateral view. I frankly confess that at that time (1913) I did not make a diagnosis of sarcoma, but was of the opinion that it was some form of chronic arthritis without any bone formation, or destruction of the articular surfaces.

Restudied more recently, the picture should have suggested a central lesion in the lower end of the femur. The most striking change is the lipomasia or osteoporosis of the tibia and fibula which could easily be explained by nonuse, but this is not present in the femur and its condyles. The portion of the inner condyle which we can see shows definite evidence of bone destruction and is not the picture of lipomasia. It is not unlike an x-ray of a bone cyst or giant-cell tumor. The shadow of the outer condyle is darker with a thin area above the epiphysis. This darker shadow can be explained by the overlapping of the two shadows of the condyles. The contrast between the shadow of the

tibia and fibula and that of the femur is against arthritis and favors a localized lesion in the lower end of the femur.

We now know that the most characteristic feature of the *x*-ray of a bone cyst, a central giant-cell tumor, or a central sarcoma, is the absence of new bone formation in the periosteum covering the expanded and thin shell present in this case.

The age of this patient—sixty-one (fifty-one at onset)—practically excludes a cyst, and the giant-cell tumor is rarely observed at this age, while the central sarcoma is not uncommon at this age. The *x*-ray of this case should be compared with Fig. 22 (P. No. 23881, Jarvis) which is an example of the changes in all the bones of the knee-joint in traumatic chronic arthritis of long duration associated with non-use.

Operation June 6, 1913. I first explored the knee-joint preparatory to a resection, to give the patient a stiff, painless limb. On opening the knee-joint and flexing, I saw a crack in the cartilage of the inner condyle near its junction with the outer. I had never seen this in arthritis. When I put a periosteal elevator in the crevice, there exuded blood. Then I felt convinced that I was dealing with a malignant bone cyst (bone aneurism). At that time I had observed four cases and had reported them in the *Annals of Surgery* for August, 1910, Figs. 39 to 43.

The wound was disinfected with carbolic acid followed by alcohol, and an amputation performed in the upper third of the thigh.

Gross Pathology. Fig. 21 (14229) is a longitudinal section through the lower end of the femur. The condyles are filled with blood and tumor tissue. There remains a capsule of cartilage and very thin bone. The shaft of the femur is also shown in the picture. Tumor tissue does not extend far up the marrow of the shaft. The crevice mentioned in the operative note can be seen in this picture.

When one looks at this specimen and then at the *x*-ray, one is surprised at the shadow produced by such a thin

bony shell. Perhaps the blood in the cavity may explain the dark areas.

If this patient had been able to walk, pathological fracture might have been expected.

Central Bone Lesions

Benign Bone Cysts (Ostitis Fibrosa)	54 cases
Central Giant-cell Tumors	50 cases
Chondroma, central	3 cases
Myxoma, central	8 cases
Central sarcoma	25 cases

Types of Central Sarcoma

Myxosarcoma	2 cases
Fibrosarcoma	4 cases
Various forms of cellular sarcoma	11 cases
Malignant bone cysts	8 cases

Myxoma. In my opinion this bone lesion, whether central or periosteal, should be classed with, and treated as, a sarcoma. The older pathologists wrote that the myxoma of bone is a benign tumor, but it always recurs. It is important, therefore, here to record the results in central myxomas.

Three cases of central myxoma, two involving a phalanx of the finger and one the shaft of the humerus, have remained well, but in these three cases tumor tissue was not exposed at operation, but the bone removed without exploratory incision by amputation (humerus, one finger) or by resection (one finger).

Two cases in which the central lesion was explored and the bone involved removed with the curette, recurred, one involving the astragalus (Fig. 28), one the os calcis. The latter is well two years after amputation and the other involving the astragalus (Figs. 28, 29, 30) recurred in the upper end of the tibia after amputation in the middle third of the tibia, and at the present time is well nine months after reamputation through the femur.

One patient died three months after an amputation at the

hip-joint for a central myxoma of the femur, and two patients with tumors involving the phalanx, have been lost track of.

As will be noted later, the results in periosteal myxoma are worse than in central myxomas, because in every instance the tumor was explored.

The danger in myxoma is the exploration of the tumor, because this tumor tissue, in my observation, is more transplantable on the same individual, than any form of normal or tumor tissue. This subject will be again discussed when we come to the exploratory operation.

The point that I wish to emphasize here is, that when the *x*-ray shows a central or marrow lesion, the probabilities are that it is benign, as 107 cases is to 31. If the central tumor proves to be a sarcoma, the chances of a cure by the complete removal of the local growth are less than 10 per cent.

We also must remember that now and then tuberculosis may produce a picture resembling a central benign or malignant tumor.

When one explores a central bone lesion, the most important thing to do first is to establish the diagnosis, and the myxoma requires special treatment.

Pathol. No. 22929. Central Myxoma of Astragalus (Figs. 28, 29, and 30.) This case will be given in brief, because the detailed description of the treatment of myxomas, central and periosteal, will have to be considered in a later paper.

The patient was a white male aged forty years, and the *x*-ray (Fig. 28) was taken in March, 1918. He complained of swelling of the ankle of two years' duration. But as there had been a previous history of gonorrhoea and infected tonsils, it was diagnosed arthritis. When the astragalus was explored, it was diagnosed giant-cell tumor. The patient came under my observation one year later with evidence of recurrence in the wound left by the removal of the astragalus piecemeal. I amputated the leg in the lower

third. Fig. 29 shows the gross specimen of the recurrent myxomatous tumor. *X*-rays of the remaining bones of this extremity after the amputation were negative. The patient returned in five months because of pain and tenderness in the region of the tubercle of the tibia (Fig. 30). I explored this area with the cautery, found the myxoma, and amputated above the knee-joint. This patient is apparently well (June, 1920) nine months after last operation. Sections from the original tumor in the astragalus and both recurrent tumors show pure myxoma. (Compare with Figs. 56, 58, and 59.)

Clinical Picture of Central Bone Tumors. The study of these 240 cases as to age of onset, duration of symptoms, symptoms of onset, such as pain, pathological fracture, swelling, disturbance of function, history of fracture and history of trauma, often leads to a pretty accurate diagnosis. When we come to the examination the two most important data, exclusive of the *x*-ray, are the blood Wassermann and the presence or absence of the Bence-Jones bodies in the urine.

In all bone lesions there should be, in addition to the *x*-ray of the affected bone, *x*-rays of other bones and of the chest.

In all adults the possibility that the bone lesion is metastatic should always be borne in mind, notwithstanding the fact that only one bone shows involvement.

Age of Onset. This is computed by subtraction of the duration of the disease since the symptom of onset from the age of the patient at the time of observation. In the majority of cases of bone tumors swelling appears so rapidly, even when it is not the symptom of onset, that it is not difficult to compute the duration of symptoms. But when there is the history of a fracture which has healed, or of localized pain months or years before swelling is noted, the question naturally arises, Shall we look upon the history of a fracture or localized pain as evidence that the disease was present at that time? In my table I have done this.

Age of Onset Ten Years or Less. Twenty cases:

Bone Cysts	16 cases
Giant-cell Tumors	3 cases
Myxoma	1 case

The patient with myxoma, who at the age of onset was under ten, had had swelling for twenty-eight years following a trauma. The tumor involved the phalanx of the first finger. The bone capsule was involved. In this case the long duration would be very unusual for a cyst or giant-cell tumor, and the most common central tumor in a phalanx is a myxoma.

It is important to remember that the giant-cell tumor has been observed in children under ten years of age. As the differential diagnosis between the cyst and giant-cell tumor is by no means always possible, and as we know that the cyst may heal spontaneously, the question is, Shall operation be performed at once, in order to establish the diagnosis and curet the giant-cell tumor early, or is there any danger in delay? I am inclined to the view that there is no danger. From my recent experience with bone cysts allowed to heal spontaneously, the subsequent x-ray pictures show very quickly evidence of ossification. Up to the present time, however, I have had no experience with delay in giant-cell tumors.

From our knowledge of the benignity of the giant-cell tumor I can see no danger from delay under x-ray observation.

From my experience up to date, the age of onset at ten years or younger, excludes a central sarcoma.

Giant Cell Tumors. Age of Onset Ten Years or Less.

Pathol. No. 6893. (V) Patient of Dr. G. G. Davis of Philadelphia. The patient was a white boy, aged two and a half years. Swelling of the lower end of the radius had been observed nine months. The x-ray (reported by Bloodgood, *Annals of Surgery*, August, 1910, Figs. 29, 30, and *Annals*

of Surgery, April, 1919, Fig. 20) shows a central shadow in the lower end of the radius with the involvement of the epiphysis; the bony shell is preserved. On the whole this x-ray is more like a cyst than the giant-cell tumor, because the light area is fairly uniform with absence of the irregular dark lines present in the giant-cell tumor. The case was immediately operated on by Dr. Davis and curetted in 1905. This patient is well (1920) fifteen years since operation. The x-ray of the result five years after operation shows restoration of the affected bone to normal (*Annals of Surgery,* August, 1910, Fig. 30).

Pathol. No. 12207. (V) Operator Dr. A. R. Kimpton of Boston. The patient is a white female aged five years. The symptom of onset was a fracture of the shaft of the tibia from a slight trauma sixteen months before operation. No x-rays were taken. Following the healing of the fracture swelling persisted with tenderness, but no marked pain. Because of the swelling an x-ray was taken (reproduced by Bloodgood, *Annals of Surgery,* August, 1912, Figs. 11 and 12). This showed a shadow in the upper third of the tibia beginning some distance below the upper epiphysis. The expansion is slight and the bony shell is quite thick; there is no new periosteal bone formation. This x-ray is different from any other bone cyst or giant-cell tumor which I have studied.

Dr. Kimpton in this case curetted in 1911 and then disinfected the cavity with Harrington's solution. There has been no recurrence (1920) nine years since operation.

Pathol. No. 17536. (V) Patient of Dr. McGill of Butte, Mont.

The lesion involved the marrow cavity of the end phalanx of the little toe. The patient was a white male aged eight years. There had been pain and swelling four months without the history of injury. The x-ray showed a small marrow shadow with the preservation of a bony shell. The toe was amputated. Up to the present time this is the only central lesion observed by me in the phalanx of a toe. All

the central lesions of the phalanges of the fingers have been myxomas (four cases). In this case the amputation could have been confined to the end phalanx.*

Should one explore for a definite central tumor when the age of onset is ten years or less? From the evidence up to date there is no apparent danger in delay. The probabilities are that the lesion is a bone cyst. If repeated *x*-ray studies do not show quickly evidence of ossification, then one should explore.

I now have three bone cysts in the shaft of the femur which were not operated on and which have completely ossified, similar to Colvin's case (Figs. 50 and 51). (See Transactions Medical Association of State of Alabama, Figs. 17 and 18.)

Age of Onset Ten to Fifteen Years. Thirteen cases:

Cysts	11 cases
Giant-cell tumors	1 case
Myxoma	1 case

The possibilities, therefore, at the ages between ten and fifteen are identical with those at ten and younger. Up to the present time we have no record of a central sarcoma at this age. The myxoma in this group was in a patient aged thirty when he came under observation, but claimed to have suffered with pain in the ankle since thirteen years of age—seventeen years.

Matthews of New York in the *Annals of Surgery* for August, 1903, reports a case of central giant-cell tumor in the mid-shaft of the tibia in a boy aged thirteen, in which there had been pain and swelling for two months. This patient is well seven years after curetting.

A case which I saw recently in consultation illustrates the fact that surgeons, roentgenologists and pathologists are not yet familiar with the importance of the easily available data as helps to diagnosis.

Pathol. No. 25656. The patient was a boy just fifteen years of age. The operation was six days after a frac-

*Recently two cases of central chondroma of the phalanx of a finger have been observed (July 10, 1920).

ture. The x-ray (Fig. 89) was taken immediately after the fracture. The fracture apparently followed a slight trauma. The x-ray showed the fracture in the middle of the shaft of the humerus, and in the center of the fracture a definite central or marrow shadow about 4 cm. in length. The lower portion of the central shadow was sharply marked off from the marrow below, but the upper was not clearly defined. There was no evident perforation of the bony shell, except at the crevices of the fracture which was slightly comminuted. In this case x-rays of other bones excluded other lesions. The x-ray of the chest was negative. The blood Wassermann was negative, and there were no Bence-Jones bodies in the urine. There was nothing in the x-ray, when studied alone, to differentiate between a myxoma, a chondroma, a cyst, a giant-cell tumor, or a central sarcoma.

Up to the present time I have recorded in my list* 10 examples of simple cysts, no giant-cell tumors, and five central sarcomas. All the central sarcomas were older, and none of those between the ages of sixteen and twenty were situated in the humerus.

On the theory of probabilities, therefore, the chances were that the lesion was a bone cyst.

As a symptom of onset pathological fracture is rarely recorded, except in the bone cyst, and here it is very common, especially in the shaft of the humerus and femur.

I have no evidence that fracture through a central giant-cell tumor leads to infiltration of the soft parts.

In this case there was great difference of opinions in the interpretation of the x-ray picture. I got the impression that the majority *feared* a central sarcoma.

The site of the fracture was explored under an Esmarch. The central shadow pictured in the x-ray was occupied by a solid mass of firm, opaque, white tissue, covered with some blood which could be easily explained by the recent fracture. The bony shell showed less expansion and was a little thicker than in the bone cysts upon which I had previously

*Of central lesions of the humerus.

operated, but I had never observed this lesion in such an early stage before. The gross appearance of this tissue shows a minute cyst 1 to 3 mm. in diameter, and a small red currant-jelly area. From the frozen section the pathologist was of the opinion that it was a myxosarcoma, but the microscopic picture, from my experience, resembled benign ostitis fibrosa.

The operator in this case decided to remove the tumor tissue, and not to resect nor to amputate, and then, giving the patient the benefit of any doubt, to employ radium treatment. It is now (June, 1920) four months since the operation, and from *x*-ray studies normal healing of the fracture has taken place.

This case illustrates the difference of opinion of experienced surgeons, roentgenologists and pathologists, on the clinical, *x*-ray, gross and microscopic diagnosis. This is due to the fact that no one has had a very large experience with these comparatively rare lesions, and no one as yet has presented and published a study of a large group of cases observed over a number of years in which the results are known. I am attempting to do this now.

I am inclined to think that longer observations will demonstrate that this patient belongs to the group of bone cysts in which the central, or marrow, cavity is filled with a solid mass of inflammatory tissue—a condition now called ostitis fibrosa.

Solid Ostitis Fibrosa. Up to the present time I have records of seven cases, two involving the shaft of the femur, three the shaft of the tibia, one the iliac bone, and in this case the shaft of the humerus.

The two cases involving the shaft of the femur have been previously reported in *Annals of Surgery* for August, 1910, where Figs. 5 and 7 illustrate the *x*-rays, and Fig. 8 the gross appearance. In these two cases the longitudinal involvement was longer than in the case just discussed. In both the symptom of onset was fracture. The age of onset was three years in one case and sixteen or eighteen in the

other. In one case the operation was four and one-half years after the first fracture for refracture, and in the other about five years after the first fracture for refracture and bending. Both patients have remained well after local removal of the disease, one ten years, the other sixteen years after operation. One of these patients was operated on by Dr. Halsted at the Johns Hopkins Hospital in 1904, and the other by Dr. Kammerer of New York in 1903. Dr. Kammerer was able to follow his case for ten years. These cases were again referred to in my paper before the Medical Association of the State of Alabama in April, 1919. (See Transactions.)

In 1916 Dr. Roche, Pathologist to St. Vincent's Hospital in Norfolk, Va., sent me a mass of tissue curetted from the center of the mid-shaft of the tibia of a female patient aged twenty-six, who had observed a swelling in this region for five years (since age of 21). Gross and microscopically, this tissue resembles that removed in Pathol. No. 25656. I advised against further operation beyond the first curetting, and this patient is well in 1920, four years. There was no pathological fracture in this case. The *x*-ray was not sent to me.

In February, 1919, Dr. Neil of Washington, D. C., sent me the *x*-ray and tissues from a case similar to that of Dr. Roche in the gross and microscopic appearance, and the *x*-rays in this case give a picture very similar to the lesion in the shaft of the humerus, just described.

Pathol. No. 24096. Figs. 32, 33. Lanahan, patient of Dr. Neil.

This patient is a white female aged twenty-four. She has observed a swelling in the mid-shaft of the tibia for sixteen years (since age of eight years). There is no history of trauma or fracture. On account of recent pain, (six months) she sought advice. The *x*-rays (Figs. 32 and 33) show a definite marrow shadow with slight expansion. The sharp outline of the shadow in the lateral view and the longitudinal dark lines in the antero-posterior view suggest,

in my opinion, a healing process undergoing ossification. This was later proved by the presence of new bone in many islands in the solid mass of ostitis fibrosa. This patient is well now one year after curetting, and the cavity is almost filled with new bone.

In this case as well as in the one of Dr. Roche, we have examples of bone cysts or ostitis fibrosa which have failed to heal spontaneously, even after periods of five and sixteen years. In these two cases the long duration of the tumor, I think, excludes a central sarcoma.

Pathol. No. 25542. Fig. 34. This is a recent observation of Dr. Baer of Baltimore, *x*-ray by Dr. Baetjer, in which the diagnosis of ostitis fibrosa was made on the clinical history and *x*-ray picture.

The patient is a white female aged seventeen. Swelling and bending of the shaft of the tibia had been present twelve years (since five years of age). There is no note on trauma, and there is no pathological fracture. Fig. 34 shows the *x*-ray. One can see in the *x*-ray evidence of ossification, similar to that in Dr. Neil's case, and this was confirmed by the microscope. Dr. Baer performed a subperiosteal resection.

In 1912 Dr. Mixter of Boston sent me a solid piece of tissue removed from the center of the crest of the iliac bone.

Pathol. No. 12378. The patient was a white female aged nineteen. Pain had been present six and one-half months; swelling two and one-half months. I did not see the *x*-ray. Dr. Mixter removed the lesion locally and reports in 1920, eight years since the operation, that there has been no recurrence. The gross specimen in this case closely resembles that in Pathol. No. 25656, in the presence of minute cysts and red currant-jelly areas.

Histology of Ostitis Fibrosa. If the bone cyst is not lined by connective tissue, one finds the picture of ostitis fibrosa in the dilated Haversian canals of the bone shell. If the bony shell of the cyst has a connective tissue lining, or is filled with a solid mass of this fibrous tissue, the histology

is practically identical with that in the dilated Haversian canals of the bony shell.

In the *Annals of Surgery* for August, 1910, Fig. 23 illustrates the picture in the bony shell, Fig. 22 the bone shell and connective-tissue linings, Figs. 20 and 21 areas containing giant cells which usually in the gross appear as red currant-jelly areas, and Fig. 19 islands of cartilage which is a rather rare finding and, if not carefully studied may be mistaken for myxomatous areas.

In nearly fifty cases of bone cysts with ostitis fibrosa which I have studied histologically, I have never found an area of pure myxoma.

But in almost all of them, as in Pathol. No. 25656, one may find very cellular areas either of spindle cells, or of round cells. The spindle cells are apparently of the connective-tissue type which ultimately form fibroblasts and fibrous tissue, and the round cells are either osteoblasts which have not yet formed bone, or proliferation of the endothelial cells of blood vessels. In a number of these cases, where the tissue has been sent to the laboratory for diagnosis, a diagnosis of sarcoma had been made from the frozen section. But in only one did the operating surgeon act upon this diagnosis and amputate.

I have carefully compared the sections of ostitis fibrosa with all my cases of periosteal and central sarcoma, and find no histological picture in the sarcoma which resembles the cellular area in ostitis fibrosa, and when these sections have been submitted to the special groups of third-year students, they have almost uniformly been able to differentiate the sarcoma from ostitis fibrosa from a study of the sections only.

Age of Onset Fifteen to Twenty Years. At this period of life the age of onset becomes less significant.

Cysts	12 cases
Central sarcoma	5 cases
Myxoma and chondroma	No cases

Among the five cases of central sarcoma there is one

which shows that the *x*-ray will not differentiate between the cyst, the giant-cell tumor and the central sarcoma, and for this reason at this age immediate exploration is indicated.

Pathol. No. 7964. Fig. 3. The *x*-ray and tissue in this case were sent to me by Dr. Ernest Codman of Boston. The patient was a white male aged seventeen. There had been a history of trauma three months before followed by pain and rapid swelling of the upper end of the fibula. The *x*-ray (a poor one) (Fig. 3) taken three months after the onset apparently shows a central tumor in the upper end of the fibula with the preservation of the bony shell. This *x*-ray is somewhat like the two I have reported (*Annals of Surgery* for August, 1912, Figs. 7 and 8, of a patient of Dr. Chambers of Baltimore, and Figs. 24 and 26, my own case). These two cases were giant-cell sarcomas. In my case (Pathol. No. 11855) I resected, and the patient is well (1920) nine years. Chambers, Fig. 4 (Pathol. No. 12926v), first curetted and later resected for a recurrence, and this patient, too, is well six years since the operation for recurrence and eight years since the curetting.

Codman's case (Fig. 3) should be always borne in mind—as a definite demonstration that the *x*-ray in the early stage of central sarcoma cannot be depended upon to differentiate the benign from the malignant lesion.

This patient of Dr. Codman refused operation when this *x*-ray was taken three months after onset. Six months later, nine months after the onset, the *x*-ray showed that the bony shell had been completely destroyed, but this *x*-ray finding does not exclude a giant-cell tumor (see my report in *Annals of Surgery*, April, 1919, Figs. 2 and 4). Dr. Codman amputated. The patient died one year later from metastasis to the lung. The tumor is a large round-cell sarcoma containing a few giant cells of the giant-cell tumor type.

The *x*-rays of this case (Pathol. No. 7964, Fig. 3) are reproduced from prints and are so poor that the diagnosis of central sarcoma may be questioned.

Treatment of Central Tumors of the Upper End of the Fibula. The case which I reported in *Annals of Surgery* for August, 1912, Pathol. No. 11855, Figs. 24, 25, and 26, demonstrates that one may resect the upper end of the fibula giving the bony shell a margin of soft parts without any interference with the future function of the limb, providing the external cutaneous nerve is not cut. But this produces only a very slight loss of function. It was accidentally cut in my case, but my patient is able to walk and dance, and there is very little loss of function. The same is true in Dr. Chambers' case.

For this reason it is my opinion that resection should be the operation of choice when the x-ray shows a central lesion of the upper end of the fibula, whether the bony shell is destroyed or not.

I have also advocated this for central tumors of the lower end of the ulna (see my report on three cases of giant-cell tumor in *Annals of Surgery*, April, 1919).

Age of Onset Over Twenty. Every type of the central bone tumor has been observed between the ages of twenty and seventy. Bone cysts are very rare after twenty years of age (5 cases). The age at which the giant-cell tumor predominates is between twenty and thirty, but eight cases have been recorded between thirty and fifty and two cases between fifty and seventy.

*Bone Cysts with Onset at Over Twenty Years of Age.**

Pathol. No. 5807. Cyst in the trochanter of the femur in a white male aged seventy. There had been a history of contusion two years; pain localized to the trochanter remained; there was some slight swelling of the trochanter. The x-ray made in 1904 is not very clear, but it shows a shadow in the trochanter with a rather thick bony shell and no periosteal bone formation. It was explored and curetted by Dr. Halsted in 1904. The cavity contained clear serum. There was no connective-tissue lining. The cavity was situated in the cancellous bone which was rather eburnated. The sections show no evidence of ostitis fibrosa. It is diffi-

*The relation if any of the juvenile and adult bone cyst with each other and with the giant-cell tumor and the malignant bone cyst is not yet determined (July 10, 1920).

cult to classify this cyst. It may have been due to a hematoma following injury. The patient was followed for one year and then lost track of.

Central tumors confined to the trochanter are rare. Dr. Prince of Rochester, N. Y., has sent me one x-ray of a bone cyst involving the great trochanter of the femur.

Pathol. No. 17871. X-ray (Fig. 2). The patient was a white female aged twenty-three. There has been localized pain for six years; pathological fracture after a slight trauma ten weeks. There has also been a slight intermittent limp for six years. Curetting was done in 1915 by Dr. Prince and there has been no recurrence in five years.

Pathol. No. 5533. This is an example of the rare type of bone cyst because of its huge size due to failure to heal. I have reported this case in *Annals of Surgery* for August, 1910 (Figs. 9 to 12). When the patient first came under observation in Johns Hopkins Hospital she gave her age as thirty-two. She was a colored woman, and the swelling which then involved the lower end of the femur and was as large as a child's head, had been present five years. So that she was twenty-seven years of age at the onset. In view of the huge size of the tumor and the inaccuracy of colored women as to their true age, it is quite possible that the condition had been present longer. At this time (1898), a clinical diagnosis of sarcoma was made and amputation advised, but refused. The patient came under observation again in 1904, six years later. The tumor had increased in size, and I was able to examine the specimen after amputation. It was a multilocular cyst involving both shaft and epiphysis with undoubted evidence of unsuccessful attempt at ossification.

The huge bone cysts of this type are rare—six out of fifty-six cases.

Pathol. No. 20646. Fig. 13. This is also an example of a huge bone cyst of the lower end of the femur. The x-ray (Fig. 13) and the data were sent me by Dr. Goodwin of the University of Virginia. The patient was a colored male

aged thirty-five; the swelling had been present for five years, since the age of thirty; two years later there was a fracture, probably pathological, which healed. Increase in size and pain for one month brought the patient to the surgical clinic. A clinical and *x*-ray diagnosis of sarcoma was made and a hip-joint amputation performed in 1914. The patient is well in 1920, six years since operation.

Pathol. No. 8324. This is another example of a large bone cyst with unsuccessful attempt at ossification, and has been completely reported by me in *Annals of Surgery* for August, 1910 (Figs. 16 and 17). The case is mentioned here, because the patient was a white female aged twenty-one when first observed in 1899; she then complained of pain and swelling of six months' duration. At that time a clinical diagnosis of sarcoma was made, amputation advised but refused. She came under the observation of another surgeon ten years later with a huge tumor, when the leg was amputated and the specimen sent to me. I am rather inclined to the view that an *x*-ray in 1899 might have led to a more correct diagnosis, and the limb saved by the proper operative procedure then.

Pathol. No. 20296. Case of Dr. Roche of solid ostitis fibrosa already discussed (page 163). This is mentioned here, because the patient claimed to be twenty-one years of age at the onset of the swelling.

Therefore, of the five cases of bone cysts the onset of which dates from a period after the age of twenty, that is, after the ossification of the epiphyses, the one in the great trochanter (age 70) apparently belongs to a different type; of the four remaining cases three are examples of huge bone cysts, the failure of which to heal spontaneously suggests, perhaps, a different type. There is, therefore, only one case of undoubted bone cyst with ostitis fibrosa, and in this case the age of onset was twenty-one, and as the patient was a female who claimed to be twenty-six at the time of observation, it is quite possible that the disease had been present longer.

Conclusions as to the Age of Onset. Up to the age of fifteen the probabilities favor the benign cyst, with a possibility of now and then a giant-cell tumor. Between fifteen and twenty cysts still predominate, but the central sarcoma must be considered. After twenty, cysts are very rare. The predominant tumors are the giant-cell tumor and the central sarcoma with a few myxomas and chondromas, all scattered up to the age of twenty. Between twenty and thirty the giant-cell tumor predominates.

Duration of Symptoms

If it is more than two years since the symptom of onset, pain, swelling, pathological fracture, or even a history of fracture, the probabilities are that the lesion is a cyst or a giant-cell tumor. Of twenty-three central sarcomas sixteen —more than one-half—came under observation within two years of the onset of the first symptom.

Central Sarcoma with Duration of Symptoms of Two Years or More. Seven out of twenty-three cases.

Pathol. No. 6426. Malignant hemorrhagic bone cyst of lower end of tibia; has suffered pain and swelling in the region of the ankle for twenty-five years; this had been diagnosed arthritis. The swelling had been intermittent. There had been a recurrence of the pain and swelling six weeks before the *x*-ray and operation. (Reported in *Annals of Surgery* for August, 1910, Fig. 39.)

Pathol. No. 24746. Fibrospindle-cell sarcoma of lower end of femur involving the condyles. Swelling for ten and one-half years after trauma. Recent pathological fracture; bony shell thin but preserved.

Pathol. No. 14229. Figs. 20, 21. Malignant hemorrhagic bone cyst of lower end of femur involving both condyles. Pain ten years; flexion two years. Treated for arthritis.

Pathol. No. 13350. Central sarcoma of lower end of humerus. Fracture nine years, swelling since; second trauma one year; rapid swelling six months. Bony shell thin, in

places destroyed with perforation and formation of a periosteal growth.

Pathol. No. 15327. Central myxosarcoma of upper end of humerus. Pain and swelling four and one-half years after trauma. Huge cystic tumor. Bone capsule and head of humerus destroyed.

Pathol. No. 2881. Malignant hemorrhagic cyst of upper end of humerus. Persistent local pain four years, swelling four months. Huge tumor. Bony shell destroyed. (Reported in *Annals of Surgery* for August, 1910, Figs. 40 and 41.)

Pathol. No. 10602. Fig. 26. Malignant hemorrhagic cyst of shaft of humerus. Pain after contusion two years. Pathological fracture five months. Bony shell preserved.

If routine *x*-ray examinations had been made after trauma, fracture, localized pain, or slight swelling, all of these cases would have been recognized earlier.

Among these seven cases one is living today (Pathol. No. 14229), Figs. 20, 21, seven years after amputation of the femur. One patient, a recent case, is still living (Pathol. No. 24746).

Onset Less Than One Month. In spite of the fact that we have had the *x*-rays for more than twenty-five years, and certainly for the past ten or fifteen years, and *x*-ray laboratories have been established all over the country, we have not yet succeeded in educating the profession and the public to the importance of the diagnostic value of *x*-rays after a trauma and the moment a patient experiences localized pain in a bone or joint, or a slight swelling.

Among these 140 patients with central bone lesions only eighteen came for examination within one month.

Of these sixteen were bone cysts; ten of these had fracture, and six marked pain and swelling after injury. This undoubtedly explains why they came under observation earlier.

One patient—a surgeon—(Pathol. No. 20115) sprained his knee in July, 1916. *X*-rays were taken at intervals until

about August tenth, when the lesion was found in the outer condyle of the lower end of the femur and operation performed September ninth. (See Figs. 11 and 12.) (Previously reported in Transactions Medical Association of State of Alabama, April, 1919, Figs. 20 and 21.)

A case of central chondroma (Pathol. No. 25254) in which the lesion was situated in the phalanx of the toe was *x*-rayed and operated on within two weeks after a pathological fracture.

Only seven out of twenty-three cases of central sarcoma were subjected to operation within six months after the onset of the first symptom. This observation gives hope that if these central sarcomas are recognized and treated within a few days or weeks after the onset of the first symptom, the probabilities of a cure will be greatly increased. Up to the present time we have had but one such opportunity (Pathol. No. 20115) (Fig. 11), and this patient is well now three and one-half years since operation. We have already recorded the percentage of cures in all cases as less than ten per cent.

Duration of Bone Cysts. The longest duration of a bone cyst is about twelve years, but in eleven cases the duration was more than five years. I will discuss this again later under Healing of Bone Cysts.

Duration of Giant-cell Tumors. The longest is nine years; in three cases over five years; in eight two to three years. There is apparently no relation between the duration of the symptoms and the preservation of the bony capsule.

Duration of Chondroma and Myxoma. Both of these may give the history of long duration with preservation of the bony shell.

Relation Between Duration of Symptoms and Local Growth. Apparently the central sarcomas grow less rapidly than the periosteal, but with bone tumors as with neoplasms in general, the duration of the symptoms does not by any means correspond with the size or infiltration of the growth. Many other factors apparently influence this

growth as repeated trauma due to either definite injury, or to the position of the bone lesion.

Symptoms of Onset. In all bone tumors, except the bone cyst, the predominant symptom of onset is localized pain, while in the cyst it is swelling or pathological fracture. Pain is frequently absent in the bone cyst. Pain has never been absent in the giant-cell tumor, nor in the malignant hemorrhagic cyst. In a few cases it has been absent in the central sarcoma.

As I have emphasized before, localized pain in a bone or joint should be looked upon as a more emphatic indication for an immediate x-ray examination than fracture. We have educated the public and the profession to the routine examination with the x-rays after fracture, but not for pain nor slight swelling, nor interference with function, such as a limp.

Symptom of Onset with Arthritis. In only two cases did the symptoms at the beginning or later suggest arthritis. They were both malignant cysts, one in the lower end of the femur, and the other in the lower end of the tibia. This is unusual, because the majority of central bone tumors, except the bone cyst, involve the lower end of the bone and the epiphysis. In periosteal sarcoma situated near the joint, joint symptoms are more apt to be present, but the bone lesion which most prominently is associated with symptoms of arthritis is tuberculosis of the epiphysis.

Limp. This has been the symptom of onset or a later symptom when the tumor has involved one of the bones of the lower extremity. But limp or loss of function has rarely been the symptom of onset in central sarcoma. It is definitely recorded in but one case.

Onset Pain with a Definite Interval Before the Appearance of Any Other Symptom. This is a very important observation and confirms the statement already made of the importance of an x-ray examination for localized pain in a bone or joint.

In ten out of twenty-three central sarcomas, pain pre-

ceded any other definite symptom from periods of four months to almost four years. In giant-cell tumors, in ten out of forty-eight cases pain was present for some time—months or years—before the appearance of the swelling.

In bone cysts this is less frequent.

Fracture. This is the predominant feature in bone cysts. Out of some fifty cases in which we have full data, there is a history of fracture in fourteen; the fracture healed, and the patient came later under observation with swelling or pathological fracture. In fourteen cases pathological fracture was apparently the first symptom; in three cases the pathological fracture occurred later. The total number of fractures is twenty-seven, that is, in more than fifty per cent. of the cases.

In the giant-cell tumor there was fracture in but five out of about fifty cases, or in ten per cent; four patients gave a history of a fracture which had healed. So we cannot tell whether it was pathological or not. In not a single case was pathological fracture the symptom of onset. In one case it was observed later.

It is not difficult to understand why fracture is more frequent in cysts than in the giant-cell tumor. It is because the cyst usually involves the shaft of the bone, and fracture has been observed chiefly when the cyst is in the shaft of the humerus or of the femur, while the giant-cell tumor as a rule involves the epiphysis, lower end of radius, upper end of tibia, and lower end of femur.

In the central sarcoma there is not a single case of pathological fracture as the symptom of onset. In the twenty-three cases in which we have definite records fracture is noted in but six, about twenty-five per cent.—one-half as frequently as in the cysts, but more frequently than in the giant-cell tumor. In two cases there is a history of fracture which had apparently healed: one nine years, one two years before. There are four pathological fractures. It is difficult to explain the infrequency of pathological fracture in central sarcoma, except that these patients may have more

pain and therefore do not expose themselves to the possibility of trauma.

The Significance of Pathological Fracture as the Symptom of Onset. This evidence indicates that fracture as the symptom of onset in a central lesion suggests a bone cyst, and if the patient is fifteen years of age or younger, it may be looked upon as almost pathognomonic. (See Pathol. No. 25656, Fig. 89, bone cyst of the shaft of the humerus, discussed on page 160.)

X-ray Picture of Central Bone Lesion. While I have numerous *x*-rays of cysts, the giant-cell tumor, chondromas and myxomas, and the hemorrhagic cystic sarcoma (bone aneurism), I have very few of the central solid sarcomas. This is due to the fact that in recent years cases of this type have not come under my observation. I have one *x*-ray of a myxosarcoma in the greater tuberosity of the humerus (Fig. 1) (Pathol. No. 19133-VII), and this differs little from Fig. 2 (Path. No. 17871-iii), a bone cyst in the trochanter of the femur. But on closer inspection one sees in the *x*-ray of the myxosarcoma of the tuberosity of the humerus a hazy dark shadow of new bone formation, or calcification of tumor tissue between the humerus and the scapula. This reaction of the periosteum with bone formation is never present in the cyst, the giant-cell tumor, the myxoma or the chondroma, and it is rare in central sarcoma, where tumor cells have infiltrated through the Haversian system into the soft parts, irritated the osteoblasts of the periosteum and stimulated bone formation. The study of the gross specimen in Fig. 1 demonstrated this, and the failure of the roentgenologist and surgeon to observe it in the *x*-ray led to a local resection and bone transplantation instead of local resection of the humerus and a piece of the scapula with the cautery, or a shoulder-girdle amputation. Later this patient came under my observation with local recurrence, but died of lung metastasis without local recurrence after the shoulder-girdle amputation which I performed.

Of eleven cases of solid cellular sarcoma I have x-rays of but three. One has already been discussed (Fig. 3) (Pathol. No. 7964-x). Here the x-ray three months after onset showed a central(?) tumor in the upper end of the tibia with preservation of the bony shell(?) impossible to differentiate from the x-rays of three cases of central giant-cell tumor of the upper end of the fibula (Fig. 4).

I have already noted that I now look upon this picture (Fig. 3, Pathol. No. 7964) as too poor for any definite conclusions.

Central Tumors of Upper End of Tibia. I have records and x-rays of seven benign cysts, six giant-cell tumors, and three central sarcomas; there is an x-ray of but one sarcoma.

Fig. 5 (Pathol. No. 16297-iii) proved, at operation, to be a bone cyst lined by a rather thick connective-tissue membrane. Fig. 6 (Pathol. No. 12276-v) proved to be a giant-cell tumor. The most striking difference is the involvement of the epiphysis in the giant-cell tumor, and the complete preservation of the epiphyseal line in the bone cyst, although on the fibular side it extends to the epiphyseal line. The apparent destruction of the bony shell in the giant-cell tumor on the fibular side is not diagnostic from a bone cyst, although on the whole it is more frequent in the giant-cell tumor. The division of the central shadow by irregular dark lines supposed to be characteristic of the giant-cell tumor, especially emphasized by some authorities some years ago, is seen here in both the cyst and the giant-cell tumor.

The clinical history of the bone cyst was (Fig. 5): White female, aged thirteen; contusion seven months ago; swelling with expansion of tibia six months; no pain, but slight tenderness. I curetted this cyst in 1915, and the patient is well in 1920, five years.

It is interesting to note here that pathological fracture has never been observed in central tumors in this portion of the tibia.

The giant-cell tumor shown in Fig. 6 was in a white male aged twenty-two; there had been pain for one year, swelling for ten months. This patient is well six years after resection with bone transplantation.

Fig. 7 (Pathol. No. 13092-x) central sarcoma of upper end of tibia diagnosed first osteomyelitis, is the only *x*-ray I have of an early central sarcoma. It will be observed that the shadow does not resemble that of a cyst or giant-cell tumor, nor that of a malignant bone cyst, but shows indefinite, irregular light areas in the upper end of the tibia involving the epiphysis with little, or no, expansion of the cortical bone and no evidence of periosteal bone formation, except at one point posterior, above the fibula. This *x*-ray picture is not unlike early osteomyelitis.

The clinical history in the case was against a bone cyst and against osteomyelitis. The patient was a white male aged thirty-nine, distinctly beyond the age for the cyst. There is the history of a trauma two years ago; the pain, tenderness and swelling after this trauma subsided, and then, one year before operation, without a second trauma, the pain and swelling returned. There was no fever or leucocytosis usually present in osteomyelitis; even in chronic osteomyelitis with pus the leucocytes show a change. There was no involvement of the soft parts which as a rule takes place within one year in osteomyelitis. Perhaps in the chronic osteomyelitis with formation of an abscess, as first described by Brody, there may be no involvement of the soft parts. But here there is sufficient destruction of the marrow to produce a central shadow. This type of osteomyelitis is rare. I have never seen an *x*-ray of such a case. Many years ago, before the advent of the *x*-rays, I operated on two cases. Both, however, showed new periosteal bone formation in the thick bony shell surrounding the abscess. In this case (Fig. 7) the head of the tibia was curetted on the diagnosis of osteomyelitis, and one month later, when a fungous tumor formed in the wound, the leg was amputated, and the patient died later with metastasis to the lungs. Un-

fortunately I can obtain no accurate description of the gross picture at the first operation. But this *x*-ray suggests that central sarcomas may give this unusual picture, demonstrating the importance of the point made in the beginning of this paper, that the pathology must be settled at the exploratory incision.

Fig. 8 (Pathol. No. 3931-x) is the photograph of a longitudinal section through what is apparently a central sarcoma of the upper end of the tibia.

Of eleven cases of central sarcoma I have already called attention to one in the upper end of the fibula in which the bone capsule was preserved and which resembled three other cases of central giant-cell tumor of the upper end of the fibula (Fig. 3), and then to one in the upper end of the tibia which had not broken through the bony shell, but had produced a mottled shadow in the upper end of the tibia (Fig. 7). And then to one (Fig. 52) involving the upper end of the radius with complete destruction of the bone. *The remaining eight cases in their gross pathology resembled the one illustrated in Fig. 8 (Pathol. No. 3931), in that there is little or no expansion of the bony shell about the central sarcoma, but a rapid perforation with prompt destruction of the bone shell and then formation of some periosteal bone with, later, a definite periosteal tumor.*

When we have a picture of this kind it is difficult to determine whether the tumor is a primary central or periosteal growth, but for the practical purposes of diagnosis and treatment this makes no difference.

Therefore, from my personal experience central sarcoma of bone is a rare lesion, and in practically all cases in which the bony shell has been preserved, the tumor has been of the type of the malignant hemorrhagic bone cyst (bone aneurism).

Central Tumors of the Lower End of the Femur. Fortunately I have two cases—one a giant-cell tumor, the other a malignant hemorrhagic bone cyst, involving the condyle of the femur. Figs. 9 and 10 (Pathologic No. 9881-v) picture

the x-ray and specimen of the giant-cell tumor, and Figs. 11 and 12 (Pathol. No. 20115-xiii) the x-ray and gross pathology of the malignant bone cyst. The bony capsule is preserved about the giant-cell tumor, while it is destroyed on the outer side about the sarcoma. In my entire experience I have never observed in a giant-cell tumor as small as this sarcoma, a destruction of the bony shell. Then, again, the light area of the giant-cell tumor is more sharply demarkated from the cancellous bone of the uninvolved femur, than the sarcoma. Figs. 9 and 10 (Pathol. No. 9881) have been previously reported by me in *Annals of Surgery* for August, 1910. I operated on this patient with Dr. DaCosta in Philadelphia in June, 1909, resecting the involved area. The patient is well (1920) eleven years.

The sarcoma (Figs. 11 and 12) was subjected by me to amputation of the femur in September, 1916, and this patient is well (1920) three and one-half years.

In the lower end of the femur I have for study 1 chondroma, 9 benign bone cysts, 11 giant-cell tumors, 2 fibrosarcomas, 6 central sarcomas, and 4 malignant bone cysts. This gives one a large opportunity to make a differential study of the x-ray pictures, but does not lead to a conclusion that any of these lesions have a characteristic x-ray appearance, at least in the stages in which they come under observation.

Benign Bone Cysts. Fig. 13 (Pathol. No. 20646-iii) is the x-ray sent me by Dr. Goodwin of the University of Virginia, and is an example of the so-called large bone cyst which has already been described (page 168). The bony capsule is practically preserved; the condyles are replaced by the shadow of the tumor; the bony capsule of the tumor rises abruptly from the shaft of the femur; there is no new periosteal bone formation at the junction of the tumor and uninvolved shaft; the tumor shadow is irregularly marked with dark lines giving it a distinctly mottled appearance. When we compare it with the large bone cyst reported in the *Annals of Surgery* for August, 1910 (Figs. 10 and 17), it is an entirely different picture: in all three the bony shell

is preserved, but in the other two the shadow was not marked by the irregular dark lines, that is, not mottled.

On the whole the x-ray resembles Fig. 14, Pathol. No. 20209-iii, a large bone cyst of the shaft of the femur of a patient of Dr. Prince of Rochester, N. Y. But in this case the shadow of the shaft of the femur is preserved to a large extent, while it is lost in Dr. Goodwin's case.

Central Chondroma. Fig. 15 (Pathol. No. 22016-ii) shows the preservation of the bony shell, but very little, if any, expansion of the lower end of the femur. It shows the mottling from the dark lines which is more common in the giant-cell tumor than in the cyst. This patient was a white female aged fifty-one, and had pain and limp for seven years. But as there was pain in other joints, she came under observation with the diagnosis of multiple arthritis, and this x-ray was found accidentally in the routine examination. The nature of the tumor was not determined until the exploratory operation. The gross appearance of the tissue beneath the bony capsule was typical of cartilage, as confirmed by the frozen section. This patient has remained well now (1920) almost four years after curetting and radium treatment. The function is good. I have no better example in my group of cases to demonstrate the difficulty of a correct diagnosis from the x-ray only. The clinical picture in this case was against a giant-cell tumor, against a central sarcoma, because all our central sarcomas reaching such size have had much more pain; then, again, the long duration of the slight symptoms—limp and slight pain—without expansion or perforation of the bony shell favored the diagnosis of a chondroma or myxoma.

Giant-Cell Tumors. Figs. 16 and 17 (Pathol. No. 25778-v) show the antero-posterior and the lateral view of a central tumor of the lower end of the femur. This is a recent case and has not yet been operated on. The age of the patient is that in which the giant-cell tumor most commonly occurs. It is of short duration—less than one year, which practically excludes a large bone cyst. The pain is very much less

than in a central sarcoma in this region. The expansion has been more rapid than in any central chondroma or myxoma under my observation. The epiphysis is involved. It shows the mottling of the giant-cell tumor. The picture closely resembles Pathol. No. 10975, reported by me in *Annals of Surgery* for 1912, Fig. 18, a giant-cell tumor of the upper end of the tibia, except that the expansion is not so marked.

Central Fibrosarcoma. Figs. 18 and 19 (Pathol. No. 23407-viii) show the *x*-ray and gross specimen. In the *x*-ray the bony capsule on the outer side is destroyed; on the inner side with part of the internal condyle, it is preserved. The preserved shaft of the femur above shows teeth-like projections of bone into the tumor. There is no periosteal bone formation. The shadow of the tumor is not mottled, although it is not smooth. When we look at the picture of the gross specimen, we see that the bone defect is filled with a solid tumor not unlike a fibroma.

Tumors of this kind are common in the lower jaw and have been removed by local resection. This patient was a white female aged twenty-nine; there was a history of contusion ten months ago, but no swelling until four months ago; there was practically no pain and no limp. If this history is correct the tumor must have grown rapidly and apparently by pressure destroyed the outer bony shell. In this case the leg was amputated without exploration, and the patient is well (1920) two years since operation. Microscopically, the tumor belongs to the group usually called fibrospindle-cell fibrosarcoma. In this type situated in the soft parts and in the lower jaw, I have never observed death from metastasis and no recurrence when the local growth was properly removed. In my opinion, in this case exploration should have been done, and when the character of the tumor had been determined, local removal with the cautery and bone transplantation would have given the patient as large an assurance of a cure and a limb with good function. This type of tumor is rare. Gross and microscopically it closely resembles solid ostitis fibrosa.

Central Sarcoma. Malignant Bone Cyst Type. (Bone Aneurism.) In the *Annals of Surgery* for August, 1910, I reported three cases: one in the lower end of the tibia (Pathol. No. 6326), one in the upper end of the humerus (Pathol. No. 2881), and one in the lower end of the femur (Pathol. No. 8951), at that time giving the literature. In the *Annals of Surgery* for April, 1919, I again referred to this subject. I now have records of five additional cases, making a total of eight cases: one in the shaft of the humerus (Pathol. No. 10602) (Fig. 26; pages 151 and 171); three in the lower end of the femur (Pathol. No. 14229, Figs. 20 and 21; pages 152, 154; Pathol. No. 19179, Figs. 23, 24, and 25; page 182; Pathol. No. 20115, Figs. 11 and 12; pages 172 and 179), and one in the shaft of the tibia (Pathol. No. 15404½).

It is interesting to note that among these eight cases four were in the lower end of the femur. In six cases the bony shell or a connective-tissue capsule confined the tumor; in two cases there was rupture with the formation of a hematoma outside the capsule or bony shell. One patient lived nine years and died of metastasis to the lung; one lived four years and died of metastasis to the lung; three are living today: one six years and other two, three and one-half years after amputation.

This central malignant bone cyst must be distinguished from the central giant-cell tumor containing blood. I have carefully discussed this from a differential-diagnosis standpoint in *Annals of Surgery* for April, 1919, and in the Transactions of the Medical Association of the State of Alabama, for April, 1919, so that it need not be repeated here.

Pathol. No. 19179-xiii. Malignant bone cyst of the lower end of the femur (Figs. 23, 24 and 25.) The *x*-rays (Figs. 23 and 24) are not strikingly different from the giant-cell tumor in this area (Figs. 16 and 17). The only point to make one suspicious is the pathological fracture which has as yet not been observed in the giant-cell tumor of the lower end of the femur, even when both the condyles and the lower

portion of the shaft were involved. Fig. 25 is a longitudinal section through the femur and the tumor. It shows the cavity, the bony shell posteriorly and the tumor tissue lining the bony shell. The thickness of this tumor tissue has varied in the different cases: in two it was so that the tumor could only be recognized after section. In all of the cases, except this one (Fig. 25), the cavity was filled with blood. In this case the contents of the cyst was clear serum. Clinically, the patient was a white female aged thirty-one; there has been pain and swelling one year, pathological fracture three months. A piece was excised and sent to me for diagnosis. The section shows a spindle-cell sarcoma. I amputated the femur in May, 1916, and the patient is well now (1920) almost four years.

Central Tumors of Lower End of Radius. Of sixteen tumors of the radius fifteen involved the lower epiphysis: thirteen giant-cell tumors and two cysts. The sixteenth case was a central sarcoma involving the upper end of the radius with complete destruction of the bony shell (Pathol. No. 17671, Figs. 52 and 53). I have also observed one case of tuberculosis of the lower end of the radius giving an *x*-ray picture like a cyst or giant-cell tumor (Fig. 37) and one in the center of the shaft of the radius which was diagnosed central sarcoma and treated with radium until the bone shell perforated and an extraosseous abscess developed.

In this case where the *x*-ray showed a central shadow in the shaft of the radius with preservation of the bony shell, the patient was an adult over thirty years of age, and it brings up perhaps the most debated question in treatment.

Some authorities are of the opinion that there is no harm to try *x*-rays or radium first, because, if the central tumor were benign, no harm would be done; if malignant, radium acts better without disturbing the neoplasm by the trauma of operation.

My personal opinion in regard to a case of this kind is this: The *x*-ray showing such a definite bone shell indicates

that the lesion could be completely resected with bone transplantation and perfect preservation of function. This is the most certain cure. For this reason, as the age practically excludes a bone cyst, I would explore to demonstrate whether the central lesion is tuberculosis, a giant-cell tumor, a myxoma, chondroma, or the rare central sarcoma. If it proved to be sarcoma, myxoma or chondroma, I would resect after destroying possible residues of tumor cells, a method to be described later under Exploratory Incision.

In this case the radium treatment first was associated with perforation and involvement of the muscle with tuberculosis, and this patient has an arm with very restricted function, while immediate exploration would have led to a correct diagnosis and resultant perfect function.

There are without doubt lesions in which radium and *x*-ray treatment should be tried first. The method of treatment varies with the bone involved, the portion of the bone involved, whether the tumor is central or periosteal, with the age of onset, duration of the tumor, the presence of a pathological fracture and our accumulated knowledge of the possible different pathological processes in the portion of bone involved. No general rule can as yet be laid down.

Fig. 36 (Pathol. No. 21191) is an *x*-ray of a bone cyst. Fig. 37 (Pathol. No. 23552) shows tuberculosis. Fig. 38 (Pathol. No. 23895), tuberculosis of the lower end of the tibia, is shown here for comparison. Fig. 39 (Pathol. No. 12927) shows a giant-cell tumor.

These cases demonstrate the difficulties of a differential diagnosis from the *x*-ray only.

Pathol. No. 21191-iii (Fig. 36), benign cyst of lower end of radius, was a white male aged twenty-six. There had been pain and swelling in the lower end of the radius for ten years; recently the pain and swelling had increased after a slight trauma. In 1917 this patient with the *x*-ray were demonstrated before a surgical society in Washington, D. C. The majority favored the diagnosis of a cyst or giant-cell tumor, a few central sarcoma. I explored the

lesion under novocaine, found a thin bony shell, a cyst lined by thin connective-tissue membrane filled with fluid. The connective-tissue lining was removed and the wound closed. The patient is well (1920) three years.

Fig. 37 (Pathol. No. 23552), tuberculosis of lower end of the radius and shaft of phalanx of index finger with involvement of the joint. This case in the *x*-ray was diagnosed a cyst.

The clinical picture as well as the *x*-ray suggested tuberculosis. It is true that cysts may be multiple, but they rarely involve a joint. This patient was a white female, aged 22, with a history and evidence of tuberculosis of lungs. Swelling of the wrist followed an injury nine months ago. The swelling was incised and pus evacuated. A sinus persisted. Four months ago, excision of piece of tissue from sinus was diagnosed sarcoma. The *x*-ray, Fig. 37, shows a shadow in the lower end of radius not unlike a bone cyst, (see Fig. 36). But the *x*-ray of the phalanx and joint of the index finger suggests tuberculosis, which was confirmed by the microscopic study of the tissue removed.

Fig. 38 (Pathol. No. 23895) is an *x*-ray of a lesion of the internal maleolus. It shows both bone destruction and bone formation. The tissues sent to me from this lesion show tuberculosis. It was diagnosed syphilis because of a Wassermann plus reaction. This *x*-ray should be compared with Fig. 37 and Fig. 59.

Fig. 39 (Pathol. No. 12927), a patient of Dr. Emil G. Beck of New York, proved to be a giant cell tumor of the lower end of the radius. It is a very early case and has distinct mottling of the central shadow in contrast to Fig. 36, a bone cyst.

Fig. 40 (Pathol. No. 16720), a giant cell tumor of lower end of radius with a preservation of the bone shell in spite of extreme expansion. It should be compared with Fig. 39, an earlier stage of this giant cell tumor, and Fig. 41 (Pathol. No. 2420), a giant cell tumor of the lower end of radius which has completely destroyed the bone shell.

Destruction or perforation of the bony shell in central bone lesions is not necessarily a sign of malignancy. I consider this point in great detail in my report to the *Annals of Surgery,* April, 1919, in relation to the central giant-cell tumor. In the Transactions of the Medical Association of the State of Alabama, April, 1919, I called attention to the fact that this perforation and partial destruction of the bony shell may take place in a bone cyst (see especially Fig. 3, Pathol. No. 21580). I emphasize this again because within the past few days one of our most experienced roentgenologists in interpreting an *x*-ray of a central lesion of the first phalanx of the little finger diagnosed sarcoma, because the bony shell was perforated at one point. The tumor proved to be a benign chondroma and could have been removed by local resection.

Figs. 42 and 43 are photographs of the forearm and the gross specimen of the *x*-ray shown in Fig. 41.

In this case, in spite of the local infiltration of the giant-cell tumor, the patient is free from recurrence more than 20 years after amputation.

Fig. 44 (Pathol. No. 1815) and Fig. 45 (Pathol. No. 6125) are photographs of the gross appearance of the central giant-cell tumor. Amputation was performed in Fig. 44, and resection in Fig. 45. A cure has been accomplished by curetting in a similar case by Dr. Chambers of Baltimore (see *Annals of Surgery,* August, 1912, Fig. 13).

Exploratory Incision. In view of this description of central lesions of bone and what we will describe later of periosteal lesions, one must conclude, at least for the present, that in a large number of cases a diagnosis cannot be made without an exploratory incision.

The object of this exploration is to establish, if possible, the nature of the lesion.

In making this incision one should employ a technique which has for its object the prevention of infection of the freshly cut normal tissues by tumor cells. This has been described under Myxoma (page 155).

The following case demonstrates how an exploratory incision for diagnosis would have prevented a mutilating amputation of the hand. Fig. 46 (Pathol. No. 24682) is a lateral x-ray of the hand, and Fig. 47 an anterior-posterior view. In this case from the clinical picture and the x-ray a positive diagnosis of sarcoma destroying the metacarpal bone of the middle finger was made, and the arm amputated without an exploratory incision. The patient was a white, male, age 34, a chauffeur, and had observed the swelling 10 months. The swelling as shown in the x-ray was large, it was soft and boggy, with oedematous skin. It was not unlike the case I reported in *Annals of Surgery,* April, 1919, Fig. 1.

If a small incision had been made under novocaine and the tumor exposed, its benign nature would have been recognized and the tumor could have been removed with the cautery, sacrificing only the middle finger and the metacarpal bone, as the lesion proved to be a giant-cell tumor.

The gross pathology is illustrated in Figs. 48 and 49.

Periosteal Bone Lesions

Cases for Study.

Exostoses	110 cases
Periosteal Chondroma	8 cases
Periosteal Myxoma and Chondromyxoma	13 cases
Periosteal Giant-cell Tumors	4 cases
Sarcoma, cellular	68 cases
Periosteal Ossifying Sarcoma	7 cases
Periosteal Myxosarcoma	5 cases

Results in Periosteal Sarcoma. This has already been discussed on page 1. In 52 cases followed there were but 2 cures, less than four per cent.

Contrast of Periosteal and Central Lesions. Attention has already been called to the striking feature of the central bone cysts, giant-cell tumors, chondromas, myxomas, and central sarcomas, especially the malignant hemorrhagic cystic type. Here the central lesion first replaces the mar-

row and cancellous bone, forms a thin bony shell, and then distends this bony shell. In this stage, in the cases studied, even when the bony shell shows considerable expansion, there is no evidence of periosteal bone formation. Attention has also been called to the fact that in a few cases a tubercular osteomyelitis localized in the shaft of long pipe bones, or in the epiphysis (lower end of the radius), we may have the same central shadow with the formation of the bony shell without ossifying periostitis.

In the bone cyst and in the giant-cell tumor the bony shell may be perforated or destroyed without the formation of periosteal bone. So far, in central chondroma* and myxoma, with one exception, destruction of the bony shell has not been observed. In one case, in which the bony shell was partially destroyed (Fig. 30) (Pathol. No. 22929), the myxoma in the tubercle of the tibia, there was no evidence of ossifying periostitis in the *x*-ray or specimen.

From a study of gross specimens apparently the central sarcoma may perforate and destroy the bony shell without producing any bone reaction in the periosteum (Fig. 52).† But this may take place (see Fig. 1 and page 175). The characteristic feature, therefore, of the central bone lesion, whether benign or malignant, is the absence of periosteal bone formation.

Another striking feature of all central bone lesions, with the exception of the healing bone cyst, is the absence of bone formation in the central bone tumor. This has been confirmed by a careful review of *x*-rays, gross specimens and microscopic sections. Bone formation has only been observed in healing ostitis fibrosa, or the bone cyst, and in these cases the ossification of the lesion may be complete, and in many cases the size and architecture of the area of bone involved is restored to normal.

In periosteal lesions the characteristic feature in the

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*I have just called attention to the perforation of the bony shell of a chondroma of the phalanx observed since this was written.

†The same has been observed in periosteal sarcoma. See Fig. 75 and page 201.

great majority of cases is periosteal bone formation and when the tumor tissue invades the shaft, or the underlying bone, especially in sarcoma, bone formation (of the endosteal type) as a rule takes place side by side with the replacement of cancellous bone and marrow tissue by the cells of the invading tumor.

In syphilitic and pyogenic periostitis and osteomyelitis we observe in the *x*-ray and in the specimen, mixed with the granulation tissue, periosteal bone formation of varying degrees. Associated with this there is destruction of the cortical cancellous bone and of the marrow tissue, sometimes with and sometimes without endosteal bone formation. Therefore, syphilitic periostitis and that usually associated with tubercular osteomyelitis and pyogenic osteomyelitis may give *x*-ray pictures difficult to interpret from periosteal sarcoma, and many mistakes have been made.

The exostosis is always a periosteal lesion. As a rule it rests upon a fairly normal bone. The exosteal growth is composed chiefly of cancellous bone. It may show an outer condensed zone of bone, and many are covered with cartilage and a few with a bursa. As a rule the exostosis does not excite much periosteal bone formation about its base. This bone lesion is the easiest to recognize in the *x*-ray.

There is little difference between the periosteal chondroma, chondromyxoma and myxoma. The chondroma and myxoma produce a shadow much lighter than that of normal bone. At the base of this periosteal lesion there is always a collar of periosteal bone formation, and in some cases this collar thins out and is continuous with the bone shell covering the entire exosteal growth. In both, the chondroma and myxoma, but more frequently in the chondroma, trabeculae of bone separate the cartilage or myxomatous tissue and are seen in the *x*-ray. As a rule in the chondroma there is little or no destruction of the cortical bone on which it rests. In the great majority of cases the periosteal chondroma, chondromyxoma and myxoma can be distinguished in the *x*-ray from the true exostosis because

of the lighter shadow. The chondroma may produce very large periosteal growths.

My study, however, demonstrates that when one operates on a periosteal growth which clinically and in the x-ray gives no suggestion of a periosteal sarcoma, the possibility of myxomatous tissue being present in the exosteal growth, should be determined at once (Fig. 56) unless the growth can be excised with a good margin of healthy tissue (Fig. 61) and without exposure of tumor tissue. If such growths contain myxomatous tissue, it is far better for the patient to be left alone, than to be explored without the precautions which I have described.

In every case of periosteal myxoma explored and then apparently completely removed there has been recurrence leading to either amputation or death. (See Fig. 58.)

Exostosis. This is a very conglomerate group, but all periosteal growths composed chiefly of bone have been placed here. There are 110 cases. In 89, as far as the records go, the exostoses were single, in thirteen the os calcis was involved on both sides. In only eight cases was the exostosis a multiple lesion of the skeleton.

Of the 89 single exostoses, as far as could be made out from the history, none were congenital, but this does not prove that they were not of congenital origin. Trauma is stated to have been a definite factor in only thirteen, fracture in five, infected wound in one. As fracture is a pretty definite clinical factor, the probabilities are that this has a small relation to exostosis, and when we consider the absence of a history of trauma and any other definite etiological factor, one gets the impression that many of these exostoses were of congenital origin, and if *x*-rays had been taken of all the bones, other exostoses would have been demonstrated. The records in this group are unfortunately meager. The patients have come under observation, because they have felt the tumor, some with and some without pain, and as the diagnosis was simple, rarely has more than one bone been *x*-rayed. There is opportunity in future

cases for a much more thorough investigation. In these single tumors practically every bone of the body has at least been involved once. The femur predominates with twenty-one cases; the os calcis next with thirteen, all bilateral; the humerus with fifteen; the tibia and phalanx of the toes with seventeen; the scapula with five; the skull with three; the remaining bones with two or one.

The age of onset varied from under ten to seventy years. In no particular age is there a predominance of the lesion. There is the same variation of the duration of symptoms.

Fig. 54 (Pathol. No. 6367-i) was diagnosed a benign exostosis 1905. It had been observed some six months. Age 30. He wore a belt and had symptoms of syphilis. No operation was performed. It is now fifteen years and the exostosis is no larger. A later *x*-ray showed a small exostosis on the other side. It has not the appearance of a syphilitic periostitis.

Fig. 55 (Pathol. No. 23886-i) is typical of a benign exostosis, but even in a case like this it would be safer to remove the growth by chiseling through the shaft of the phalanx.

Exostosis and Myxoma. Fig. 56 (Pathol. No. 10150-i) was diagnosed from this *x*-ray a benign exostosis of the lower end of the femur. The surgeon in 1909 removed this apparently bony tumor piecemeal. There was recurrence and death in four years. I was unable to ascertain the details of the recurrence, but apparently there was no doubt about the recurrence in the region of the knee-joint, and death with symptoms of long involvement. When I restudied the tissues removed in this case definite areas of myxoma were found mixed with the cancellous bone.

Up to the present time this is the only case of exostosis in which I found areas of myxoma, and this is the only patient who has died of the disease.

Multiple Exostoses. This is a congenital disease of the skeleton of which I have now eight cases—a condition not at all difficult to recognize clinically and in the *x*-ray. It will not be discussed here. But as stated before, the multi-

plicity of bone lesions excludes sarcoma, and there is no difficulty in recognizing in the x-ray the multiple benign lesions of bone—exostosis and ostitis fibrosa, from metastatic bone lesions.

Periosteal Chondroma. Eight cases. These are to be distinguished from the exostosis because they are composed chiefly of cartilage in the central zone of the exosteal growth, while in the exostosis, if cartilage is present, it forms the capsule of the bony growth beneath.

This classification may be unnecessary. Perhaps all periosteal chondromas might be studied with exostosis. But I have placed them in a separate group, because of the importance and the frequency of the association of cartilage with myxomatous tissue. I have just shown that of eighty-nine true exostoses but one contained myxomatous tissue, while of fourteen chiefly cartilage exostoses no less than six contained myxomatous tissue, and when myxoma is present and the lesion is explored and not properly cauterized, there will be a recurrence leading to amputation or death. For this reason one should be more suspicious of the presence of myxomatous tissne in all apparently cartilage tumors, whether periosteal or central.

The pure periosteal chondromas among our cases have been distributed as follows: ribs three cases; femur one; tibia, os calcis, sacrum, metatarsus one each. As contrasted with myxoma all the periosteal chondromas are well, and whether the operation has been incomplete or complete, or whether the growth was removed piecemeal or entire. One case situated on the metacarpal bone recurred, but is well now (1920) six years after the removal of the recurrent tumor with preservation of the bone.*

There is nothing characteristic in the age of onset of the chondroma. The tumors may be of long or short duration. Fig. 57 (Pathol. No. 25766-ii) is the x-ray of a periosteal chondroma of the shaft of the femur. This picture should be compared with Fig. 14 (Pathol. No. 20209), a benign bone cyst. This huge periosteal chondroma shows all the

*Since writing this I have received data and specimen of a Recurrent Chondroma. A special report will be published on this type. July 15, 1920.

characteristics of a benign periosteal growth. The only periosteal sarcoma with much bone formation which gives a picture anything like this is Fig. 70 (Pathol. No. 23284-ix) (vi). The shadow of the outer bone capsule in this chondroma looks like the surface of a wart—a condition never present in a bone cyst. There is no destruction or infiltration of the shaft beneath. The most interesting feature is the definite abnormality of the shaft of the femur from which the cartilage growth apparently arises, suggesting a congenital defect. This patient was a girl aged sixteen, and had observed a lump on the medial side of the lower third of the femur for ten years. Recently she had been working as a sales girl and had found that standing produced pain; for the past three months the mass had been increasing in size and the pain getting worse. It was diagnosed by Dr. Baetjer an osteochondroma, and removed piecemeal by Dr. Reid of Johns Hopkins Hospital. The tumor is as large as two oranges; it is composed chiefly of cartilage with areas of cancellous bone, but in the tumor there are numerous cysts and soft gelatinous areas which in the fresh suggested to me myxomatous tissue. But frozen sections of these apparently myxomatous areas demonstrated them to be cartilage.

This case shows that one cannot with certainty differentiate softened cartilage areas from myxomatous tissue.

Periosteal Myxoma and Chondro-myxoma. Thirteen cases. Unfortunately in these cases, when operated upon, the dangerous nature of the myxoma was not recognized and in spite of the complete removal of the periosteal growth, there has been recurrence and death in all the cases followed.

Fig. 58 (Pathol. No. 6773) is the *x*-ray of an apparently innocent periosteal growth which microscopically proved to be a pure myxoma. The collar of periosteal bone is seen, the cortical bone beneath, perhaps slightly depressed, shows no infiltration or destruction, and the marrow cavity of the shaft of the humerus seems normal. This patient, a white

female, aged sixty years, gave a history of trauma to this arm three or four years before operation. Since this trauma there has been a local area of pain and tenderness in the region of the present tumor, but the lump had been observed but four months. The growth was removed piecemeal in 1905. The patient died in 1915, ten years later, with evident metatasis to the scalp and mediastinum. But, as there was no autopsy, we do not know the pathology of the metastatic tumor. Between 1905 and 1912 there were seven operations for recurrences, either in the soft parts or the humerus. All the recurrent tumors were pure myxomas. Finally in 1912 the arm was amputated at the shoulder-joint.

One could have no more impressive evidence that a myxoma for practical purposes is a malignant tumor. In the discussion of central myxomas I have recorded the fact that the only cures were those in which the involved bone had been removed by resection or amputation without exposure of the tumor tissue.

Periosteal Myxoma and Bone Cysts. Among the fifty-four cases of bone cysts, in only one did the local lesion in the *x*-ray suggest a periosteal lesion, and when this case came under my observation in 1913 I could not but recollect the disastrous result in the periosteal myxoma just described. For this reason I chiselled off the periosteal growth with a good margin of healthy bone beneath and did not see the tumor (Fig. 61) until after it had been removed. It then proved to be a benign bone cyst. Fig. 59 (Pathol. No. 10693-iii) is the *x*-ray of the lesion of the lower end of the fibula, and it does resemble the periosteal myxoma. Fig. 60 (Pathol. No. 10693-iii) is the *x*-ray after operation. This patient is well (1920) seven years after operation. She was a white female aged nineteen and had observed a swelling of the lower end of the fibula eleven months. There had been no pain and no definite history of trauma.

Periosteal Giant-cell Tumor. These are rare. We have

a record of but four cases: one involving the lower end of the ulna; two the tubercle of the tibia, and one involving the sacrum. We have not observed a case of this type since 1912. We have no *x*-rays of these cases. From the study of the gross specimens they are periosteal growths not associated with bone formation, similar to the epulis of the jaw. The bone beneath shows very little destruction. They can be recognized by their gross and microscopic appearance. The two cases involving the tubercle of the tibia demonstrate the importance of bearing this benign lesion in mind. The first case (Pathol. No. 1448) was first curetted, and even after a second curetting, remained well as long as it was followed, seven years. The second case also recurred after partial excision, was unnecessarily amputated. In both of these cases the tubercle of the tibia was destroyed by the periosteal growth, but examination of the case amputated demonstrates that the shaft beneath was not involved, and the local growth could have been resected. These patients were forty-eight and forty-five years of age; in one pain fourteen months, tumor four months; in the other pain two years, tumor one year. *In my series of cases these are the only tumors confined to the tubercle of the tibia.*

Enlargement of the tubercle of the tibia after slight trauma (fracture of the beak-shaped process, Schlatter-Osgood disease) is not an uncommon lesion and must be distinguished from tuberculosis, osteomyelitis and tumor. In the cases which I have observed the diagnosis was not difficult from the history and the *x*-ray.

The periosteal giant-cell tumor of the lower end of the ulna was of interest, because the tumor pulsated. This is the only pulsating tumor in the group which I have studied. (Reported in *Annals of Surgery,* August, 1912, Fig. 15.)

Periosteal Sarcoma. This is the most common neoplasm next to the exostosis, and the most fateful—less than four per cent. of cures.

X-ray Appearance of Periosteal Sarcoma. From the

x-ray standpoint these periosteal sarcomas may be divided into the following groups:

1. Cases in which the *x*-ray shows a typical radiating formation of periosteal bone, or a light fuzzy shadow with very slight destruction of the cortical bone beneath. This is perhaps the most common type, and in my experience is sufficiently characteristic to allow a positive diagnosis to be followed by resection or amputation without exploratory incision.

2. Here the periosteal new bone formation is so extensive that one must consider some type of exostosis or ossifying myositis. This form is rare.

3. Here the *x*-ray suggests osteomyelitis, because, in addition to the periosteal bone formation, the shaft shows light and dark areas: the light areas due to central destruction by the infiltrating tumor, the dark areas due to either periosteal or endosteal bone formation.

4. Here there is a palpable periosteal mass, but the *x*-ray shows no periosteal bone formation, no destruction of the cortical bone, but only changes in the marrow, or central, area due to infiltration by the tumor.

Group 1. Pathol. No. 15557-ix. Fig. 62 antero-posterior and Fig. 63, lateral view. The *x*-rays show, surrounding the lower end of the femur, above the epiphyseal line a few perpendicular rays of new bone formation, and in the antero-posterior view, above the internal condyle some fuzzy bone formation. In both views, especially the antero-posterior, the shadow of the internal condyle and the shaft above show irregular dark and light areas.

From my studies this case is typical of the *x*-ray of a periosteal sarcoma of the most malignant type. I have not an *x*-ray of syphilitic periostitis, osteomyelitis, or any type of benign periosteal growth which presents this peculiar combination of periosteal bone formation and changes from the normal in the shadow of the shaft.

Fig. 64 (Pathol. No. 15557-ix) is the photograph of a longitudinal section through the lower end of the femur.

It pictures the periosteal growth most marked in the region of the internal condyle, and the infiltration of the bone beneath, explaining the x-ray picture. The portion of the shaft above is uninvolved, both in the x-ray and in the specimen. This is confirmed by the microscope.

Clinical History. Pathol. No. 15557-ix. Figs. 62, 63, and 64. White male aged twenty-one; pain and swelling in region of knee and condyles present two and one-half months after trauma; diagnosed tuberculosis and treated without x-ray examination. This patient was referred to me in April, 1914, and the diagnosis of periosteal sarcoma was made from the x-rays (Figs. 62 and 63). Although I advised amputation rather than resection with bone transplantation, the patient chose the latter, and the specimen shows (Fig. 64) the resected bone denuded of its soft parts. Microscopically, the tumor was a mixed large-spindle-and-round-cell sarcoma with numerous giant mononuclear cells and with many giant cells of the giant-cell tumor type. There was both periosteal and exosteal bone formation, with here and there islands of epiphyseal cartilage. The bone transplantation from the tibia was successful, but four and one-half months later the patient requested amputation, preferring an artificial limb with a movable knee to the stiff joint. No tumor was found in the amputated leg. The patient died of metastasis two years and seven months after the first operation. Symptoms of lung metastasis were present about three months before death. The x-ray of the chest before operation and eighteen months later showed no evidence of metastasis.

Pathol. No. 25761. Fig. 65 is the x-ray of the upper end of the femur. It shows the fuzzy periosteal growth on the neck of the femur characteristic of the periosteal sarcoma. The perpendicular radiating bone formation is not present. The shadow of the neck and upper portion of the shaft between the trochanters is undoubtedly abnormal: mottled darker areas due to periosteal or endosteal bone formation, or to both. Fig. 66 is a photograph of a longitudinal sec-

tion through the femur and shows a pathological picture practically identical with that in the previous case. The diagnosis was made by Drs. Baetjer and Baer and a hip-joint amputation performed without exploratory incision.

The patient was a white male aged eighteen; there had been gradually increasing pain and stiffness for three months after a trauma. Microscopically it is a round-cell sarcoma with perithelial arrangement, and there is both endosteal and periosteal bone formation.

These two cases represent the most common form of periosteal sarcoma. In the next two cases the *x*-ray picture is not quite so typical and perhaps some benign form of ossifying periostitis should be considered.

Fig. 67 (Pathol. No. 24428-ix). This is the *x*-ray in which the shadow of the periosteal bone formation and the slight changes in the shaft of the fibula might be due to a syphilitic periostitis. Yet, clinically, there was a large palpable tumor of spindle shape surrounding the upper end of the bone. This tumor was resected by Dr. Winthrop of Mobile, Ala., without exploratory incision. The tumor (Fig. 68) is quite large, and bone formation is present only near the shaft. Microscopically, it is a mixed large-round and spindle-cell sarcoma with mononuclear giant cells, some periosteal and endosteal bone formation. In a similar case, I am inclined to think, it would be wiser before operation to give a therapeutic dose of salvarsan, even though the Wassermann is negative.

Fig. 69 (Pathol. No. 22795-ix). *X*-ray of the lower end of the femur. If one looks at the perpendicular ray-like bone formations above the external condyle with a fairly normal bone below, one might think of an exostosis of the osteochondroma type. I have never seen this ray formation so marked in syphilis. But when one looks at the entire picture and sees the shadow of a large periosteal growth with slight ray and foggy bone formation on the medial side and a shadow of the shaft undoubtedly darkened by periosteal bone formation, one can be pretty certain that

the lesion is a periosteal sarcoma of the most malignant and common type.

In this case Dr. Baetjer made the diagnosis of periosteal sarcoma, and Dr. Follis of Johns Hopkins Hospital amputated without exploratory incision.

The patient was a white male aged twenty-two; there is no history of trauma. He had had pain for two years; swelling for one year and eleven months; seven months after the onset of the pain, even though there was some little swelling, he was admitted into the U. S. Army and continued in full duty to about three months before operation; for six weeks there had been increased pain and swelling. Clinically there was a large spindle-shaped swelling surrounding the lower end of the femur. Microscopically, the tumor is a perithelial round-cell sarcoma.

Group 2. Excessive Periosteal Bone Formation. In this group there are perhaps seven cases, but only one good *x*-ray. Fig. 70 (Pathol. No. 23284-ix-vi) shows the *x*-ray of the lower end of the femur. The most marked feature is the periosteal bone formation of the lower third of the femur covering the condyle with no marked change in the shadow of the shaft. On the whole it represents ossifying myositis. On closer inspection of this *x*-ray one sees posterior, above the popliteal space, a circumscribed dark shadow containing some bone which suggests a portion of the tumor with less bone formation.

I saw this patient and the *x*-ray two years after the onset, and she died with symptoms of metastasis to the lung without operation about one year later. There is, first, an indefinite history of a lump in this region for twenty years following riding horseback and suggesting ossifying myositis. The present swelling is of two years' duration after an injury.

With rare exceptions the area of periosteal bone formation shown in the *x*-ray is very much smaller than the palpable periosteal tumor, but in cases of this kind the area of periosteal bone formation in the *x*-ray seems to correspond with the size of the palpable tumor.

On the lower jaw we have three cases of this type, and all have remained well since resection, but when present on the shaft of the femur (three cases: two lower end, one upper end) and on the upper end of the fibula (two cases) and on the rib or skull (each one case) these periosteal sarcomas with marked bone formation have been just as malignant as the other types of periosteal sarcoma. One was a small-round-cell sarcoma, a type usually not associated with much bone formation. The other cases were of the mixed spindle-and-round-cell type. It is difficult to explain the excessive bone formation in these seven cases of periosteal sarcoma. The only fact, up to the present time, that seems impressive is that as a rule the earlier you *x*-ray a periosteal sarcoma after the onset of the symptoms, the more often do you find periosteal bone formation. In later cases it is less frequent, but in Fig. 70 it was still present two years after onset. In periosteal sarcoma, with but few exceptions, the bone formation is present in the tumor near the shaft; in the periphery of the tumor there is little, if any, bone formation.

Group 3. X-ray picture like osteomyelitis. Fig. 71 (Pathol. No. 10537-ix). X-ray of a periosteal sarcoma of the upper third of the tibia. This *x*-ray was submitted to the members of the American Orthopedic Association ten years ago. In the group there was a number of roentgenologists and visiting surgeons from abroad. The diagnosis made was either syphilis or osteomyelitis; no one diagnosed sarcoma. The patient was a white male aged seventeen; pain six months; swelling five months. The patient died within one year after amputation. Microscopically, it is a small-round-cell sarcoma with myxomatous and fibro-spindle-cell areas; there is both periosteal and endosteal bone formation. Beneath the periosteal growth the shaft is involved to the marrow.

Fig. 72 (Pathol. No. 15745-ix) shows the *x*-ray of the upper end of the femur. This patient was under the observation of Dr. Danforth of Providence, R. I., who was rather inclined to the diagnosis of osteomyelitis. He explored and

removed a piece for diagnosis, and kindly sent the sections to me. The section shows largely new bone formation, but there is one area of undoubted small-round-cell sarcoma. Amputation was refused, and the patient died three months later of metastasis to the lung. The patient was fourteen years of age; pain eighteen months; swelling eight months.

This case demonstrates the difficulty of a differential diagnosis from the *x*-ray only.

Fig. 73 (Pathol. No. 23894-ix) is the *x*-ray of the upper end of the tibia. This was diagnosed chronic osteomyelitis by Baetjer, explored by Reid of Johns Hopkins Hospital in December, 1918; diagnosed sarcoma and amputation performed.

The patient was a white male aged fifteen; pain one year; swelling eight months. In the gross (Fig. 74) there was a small periosteal growth with a large area of involvement of the shaft and surrounding sclerosis. Microscopically, this is an alveolar round-cell sarcoma, suggesting endothelioma. There is both periosteal and endosteal bone formation.

In these last two cases (Figs. 72 and 73) diagnosed osteomyelitis the typical ray and fuzzy bone formation of periosteal sarcoma is absent. The marked features are widening and thickening of the shaft with mottled areas of bone destruction, mottled darker areas of bone formation, and definite thickening from periosteal bone formation. In the first case (Fig. 72) light areas of new periosteal bone formation are evident, but they do not take the shape of rays or of the fuzzy type.

In these cases of periosteal sarcoma diagnosed in the *x*-ray osteomyelitis the clinical picture was not that of osteomyelitis, and exploration would have differentiated at once.

Group 4. Periosteal sarcoma with no periosteal bone formation, but with evidence of marrow involvement in the *x*-ray. This is very rare.

Fig. 75 (Pathol. No. 25505-ix) is an *x*-ray sent to me by Dr. Danforth of Providence, R. I. The patient had a palpa-

ble mass in the soft parts about the lower end of the femur which had been present some months, and the question was as to the interpretation of the x-ray findings. I had never seen a picture like it and could not interpret it. Dr. Danforth explored the tumor and sent a piece of the tissue to me. It was spindle-cell sarcoma. A few weeks later pathological fracture occurred and the leg was amputated. I have not yet received the specimen, nor the full clinical history.

This case is a demonstration of what may be expected in the future, when as a routine x-rays will be taken in cases in which no x-rays have been taken before, and when we have the opportunity to x-ray bone lesions very quickly after the symptom of onset, we are to see pictures of bone changes with which our previous experience has not made us familiar, and until we have a large experience, diagnosis will be more difficult in this early stage.

Periostitis

I have a few cases of different types of periostitis, which have been diagnosed from the x-ray sarcoma, and in a few of these the piece excised has been diagnosed microscopically sarcoma. These cases may be classified as follows:

1. Traumatic Ossifying Periostitis.
2. Syphilitic Ossifying Periostitis.
3. Pyogenic Ossifying Periostitis, associated with osteomyelitis.
4. Ossifying Periostitis about tubercular lesions of bone.
5. Ossifying Periostitis associated with benign tumors near bone.

1. *Traumatic Ossifying Periostitis.* Fig. 78 (Pathol. No. 10313 BD) is an x-ray picturing a localized periosteal growth from the shaft of the mid-humerus and also a periosteal growth from the shaft of the clavicle near the acromial process. Ten years ago this was first diagnosed periosteal sarcoma, and the piece removed was diagnosed spindle-cell sarcoma: amputation of the shoulder-joint advised. I saw this patient in 1910. The surgeon and the

roentgenologist who examined this patient first apparently did not see the lesion of the clavicle. The two definite periosteal lesions, in my experience, excluded sarcoma, and this has been confirmed in the cases observed since. The section of the piece excised showed new periosteal bone imbedded in granulation tissue. This patient is well with good function, in 1920—ten years; he is an officer in the U. S. Army.

When I saw him in 1910 he was seventeen years of age and had received a severe contusion of the shoulder and arm in a football scrimmage. Three weeks later, after the first marked swelling and echymosis had disappeared, a nodule could be palpated attached to the shaft of the humerus, as shown in the *x*-ray, and this was immediately explored.

X-ray of Bones and Joints After Trauma. In view of the fact that the majority of benign and malignant bone lesions give a history of trauma and very few a history of fracture, it seems to be of the greatest importance that an *x*-ray should be taken after such bone and joint injuries not associated with fracture and dislocation, and that this *x*-ray examination be continued until all symptoms have disappeared. The moment the *x*-ray shows any change of bone production or bone destruction there should be immediate investigation to establish the pathology.

I have already called attention to the fact that in the true exostosis a history of trauma or fracture is unusual, and have been surprised at the infrequency of periosteal bone formation after trauma. In a large number of cases I have *x*-ray studies after trauma and at intervals until all symptoms had disappeared, with negative findings. In only one case (Fig. 11) (Pathol. No. 20115, pages 172 and 179) in which the *x*-rays were negative after the injury, did a later *x*-ray picture show the development of the malignant hemorrhagic cyst in the outer condyle of the femur.

I have also called attention to the changes that may take place in the cancellous bone of the epiphysis after traumatic arthritis (Fig. 22) (Pathol. No. 23881, page 154). The first

changes apparently are an osteoporosis due to lipomasia, the result of non-use; then mottled dark areas due to regeneration of bone secondary to beginning function. The diagnostic point here is that all the bones contiguous to the joint are involved.

Pain and Tenderness After Trauma. I have a number of observations which demonstrate that localized pain and tenderness without swelling may persist months, even up to nine, after a contusion of a bone with negative *x*-ray findings. Cases of this kind should be carefully watched and frequently *x*-rayed. That benign ossifying periostitis may follow trauma is illustrated in Fig. 78 of the football player, and the shadow may simulate periosteal sarcoma.

2. *Syphilitic Ossifying Periostitis.* When the syphilitic bone lesions are multiple, sarcoma can be excluded. But often this lesion involves a single bone. In all of my cases, except one, the Wassermann was positive and the bone lesion has shown almost immediate improvement after salvarsan. In one case it was negative, but the bone lesion of the tibia responded immediately to salvarsan. In this case the *x*-ray had been diagnosed sarcoma and amputation advised.

Fig. 79 (Pathol. No. 11769-BD) and Fig. 80 show a photograph of the forearm and the *x*-ray of the involved ulna in which a diagnosis of sarcoma had been made, both from the *x*-ray and from a piece excised. I saw this patient in 1911 because amputation of the arm had been advised. Surrounding the lower end of the ulna was a spindle swelling supposed to be typical of periosteal sarcoma. The *x*-ray shows chiefly bone destruction, but there is undoubted thickening of the lower end of the ulna due to periosteal and perhaps endosteal bone formation. As the exploratory incision had not entered the shaft of the ulna, these light areas of bone destruction cannot be explained by removal of tissue at operation.

This *x*-ray should be compared with Fig. 73 and Fig. 76, both periosteal sarcoma, and Fig. 83 (JCB. No. 8415), pyogenic osteomyelitis.

The patient under discussion was a white male aged seventeen. There was no definite history of trauma. For eight months he had had restricted supination of the forearm followed by swelling of the lower end of the ulna. At the end of two months an x-ray was taken and a piece excised, sarcoma diagnosed, and treatment by Coley's serum tried. As there was no improvement after six months, amputation was advised. No examination of the blood had been made. Our routine Wasserman examination in this case was positive, and the swelling rapidly disappeared under salvarsan treatment. The syphilitic infection was probably congenital in origin, because the father and two brothers also gave positive Wassermanns. This patient is well now (1920) nine years.

This observation demonstrates that a routine Wassermann in bone lesions is as essential as a routine x-ray, and in periosteal lesions it is my opinion that a therapeutic dose of salvarsan should be given even when the Wassermann is negative.

3. *Pyogenic Ossifying Periostitis.* It is almost unique in infections of bone with organisms other than with the spirochaeta and gonococcus, to observe periosteal involvement without marrow, or central, involvement. In many cases of syphilis the entire change is seen in the periosteal bone formation with or without slight destruction of the cortical layer. The most frequent situation of ossifying gonorrhaeal periostitis is the os calcis. In all the cases of gonorrhoeal periostitis with periosteal bone formation which I have studied more than one bone have been involved, and this when the clinical picture had excluded sarcoma. In the cases of ossifying periostitis of the os calcis apparently due to the gonococcus the lesion has usually been bilateral, and up to the present time I have never observed a periosteal sarcoma of the os calcis, nor in any of the tarsal or carpal bones. There is one periosteal sarcoma of the metatarsus.

Fig. 81 (Pathol. No. 16865) is the x-ray of a unique case.

Here there is definite periosteal bone formation of the upper third of the femur with some destruction of the cortical layer, but apparently an uninvolved marrow cavity. There was a palpable spindle swelling about the shaft of the upper third of the femur, much larger than the area pictured in the x-ray. Clinically, it was the picture of a periosteal sarcoma. When I observed this patient in 1914 I was less familiar with the x-ray appearance of periosteal sarcomas than I am today, and I was suspicious of a sarcoma. Since then when I compare this x-ray with every case of periosteal sarcoma confirmed by pathological diagnosis and death from the disease, it seems to present differences. But whether sarcoma could be excluded if a similar case came under observation today, I am by no means certain. This patient was a white male aged forty-two: the only fact in his history, never yet recorded in a periosteal sarcoma, was the presence of a carbuncle on the inner side of the lower third of the left thigh. This carbuncle began five months before I saw the patient and healed without operation in two weeks. Then there was pain in the upper third of the thigh followed by swelling below the trochanter. The Wassermann was negative. The resident surgeon at St. Agnes Hospital told this patient that the leg would probably have to be amputated at the hip. The patient immediately left the hospital, went to another hospital where a piece was excised for diagnosis and diagnosed sarcoma. The tissue was sent to the laboratory, and I have submitted the sections to a number of pathologists. The majority were of the opinion that the lesion is sarcoma, although this section does not resemble any sarcoma which I have studied, but rather the picture of spindle-cell granulation tissue in which there is imbedded much new bone. Some two years later the patient again came under my observation, apparently well, and the x-ray shows (Fig. 82) that the lesion has practically healed, but there is still thickening. This patient is well today, six years since he was first seen by me.

A case of this kind demonstrates that some of the so-called

cures of periosteal sarcoma after amputation, serum, x-ray, or radium belong to this type of periosteal lesion. How frequently it occurs, I am unable to determine. Had I amputated in this case and taken the majority diagnosis of the section, this patient could be placed as the third cure of periosteal sarcoma.

Fig. 83 (JCB. 8415) is an *x*-ray of a lesion in the lower third of the ulna which resembles somewhat periosteal sarcoma with marrow involvement, or syphilis. Clinically, on account of the slight fever and leucocytosis, it suggested pyogenic osteomyelitis. The symptoms—pain and swelling—had been present about two months. The exploration found a pus cavity surrounded by granulation tissue with no pus formation outside the bone. The lesion healed promptly and the patient has remained well.

4. *Ossifying Periostitis About Tubercular Lesions of Bone.* Fig. 84 (Pathol. No. 24311) is an example of extensive periosteal bone formation associated with a tubercular arthritis of the metacarpo-carpal joint of the thumb. In this *x*-ray the destruction of the articular surface of the bones in this joint associated with periosteal bone formation about the shaft of the metacarpal bone exclude sarcoma. In this case the patient was first operated on for tuberculosis of the tendon-sheath of the extensor to this thumb over this joint. At this time and for some months later the *x*-ray of the hand showed no bone changes. In order to save the tendon, the tubercular tissue could not be completely removed. Later the *x*-ray showed the joint destruction, and the periosteal bone formation. Only the joint involvement was excised. The wound has now healed, the periosteal bone formation has almost disappeared, and the function of the thumb is unimpaired.

The repeated *x*-ray examinations in this case undoubtedly allowed the early recognition and prompt treatment of the tubercular joint infection.

I have no cases of tuberculosis of bone diagnosed sarcoma because of periosteal involvement. I have already

discussed those few cases of tuberculosis of the central or epiphyseal area of bone without periosteal changes which have been diagnosed from the x-ray central sarcoma.

5. *Ossifying Periostitis Associated with Benign Tumors Near Bone.* This is unusual. Fig. 85 (Pathol. No. 24367) is an x-ray showing periosteal bone formation from the shaft of the lower end of the femur, and from the position of the periosteal shadow this new bone formation might be within the capsule of the joint. This patient was referred to me by Dr. Hoke of Atlanta, Ga. In April, 1919, Dr. Hoke removed from the knee-joint near the patellar tendon a tumor about the size of the end of an adult thumb. This tumor is a chondroma. The patient gave a history of pain and stiffness of the right knee for two years with attacks of intermittent hydrops. The tonsils had been removed, and the knee put in plaster. Later Dr. Hoke found the tumor and removed it. Five months after this operation I examined the patient and the x-ray and in view of the fact that the tumor removed from the knee-joint was a pure chondroma, I advised against exploring because of the x-ray picture. This patient in April, 1920, seven months later, is very much better, but the shadows of bone formation still persist.

Fig. 86 (Pathol. No. 23323) is an x-ray of the skull showing a bone defect in the frontal above the right eyebrow. This patient was operated on by my colleague Dr. Seegar at St. Agnes in June, 1918, almost two years ago. The patient was a white girl aged ten, and had observed a swelling above the right eyebrow for two months. The swelling was about the size of a fifty-cent piece, the skin normal. It was distinctly compressible, and one could feel the edges of the bone defect. At the operation by Dr. Seegar the fresh appearance of the tumor tissue suggested sarcoma. For this reason he felt that it was inoperable and only partially removed it. From my study of the section I was inclined to the diagnosis of a capillary angioma. The Wassermann in this case was negative. There has been no re-

currence within one year; the bone defect has completely healed and now, almost two years since operation, there is no sign of recurrence.

Here, therefore, we have another observation which could be easily diagnosed sarcoma and recorded as a cure after any method of treatment.

Quite recently there was referred to me an adult with a large fluctuating swelling above the left eyebrow of one month's duration, and the *x*-ray showed a similar defect in the frontal bone. In the beginning there had been intense pain in the eyebrow; then swelling with relief of pain; then fluctuation with redness of the skin—the clinical picture of an abscess. In addition to the bone defect, the *x*-ray showed cloudiness of the frontal sinus. Incision found a pus cavity lined by hemorrhagic granulation tissue, the sections from which somewhat resembled sarcoma. The wound healed rapidly after incision, and the patient is now well in spite of the fact that he refused to have the sinus drained through the nose. The pus contained many cocci in cover slips. Unfortunately cultures, although made, were not carried through in the laboratory.

Conclusions. In spite of a more or less continuous study of lesions of bone for twenty-seven years based upon clinical, pathological and later *x*-ray investigation, and in spite of a thorough reading of the literature which has been critically reviewed in the December numbers of *Progressive Medicine* from 1899 to 1918, I find myself unable to summarize the results of this study in a short number of concluding remarks.

The most striking fact is the absence of solid central sarcoma in recent years. The relative number of periosteal sarcoma and malignant bone cysts and of all other types of benign and malignant bone lesions continue in about the same relative proportion, but cases in which we can make a diagnosis of central sarcoma are conspicuous by their absence. It is true that when we have both a periosteal and central neoplasm with more or less destruction of the cor-

tical bone, we have classed these with periosteal sarcoma and for practical purposes they are that.

I would welcome an opportunity to study a solid central sarcoma in which there is no periosteal growth.

At the present time the diagnosis of a bone lesion, especially in its early stage, in the great majority of cases must be made at the exploratory incision, and in making this incision the surgeon should be prepared to prevent the dissemination of tumor tissue, especially of myxoma, into the exposed normal tissues. This is most important when the lesion can be removed by local resection rather than amputation. The greatest danger appears to be in myxoma. The technique of destruction of the tumor tissue exposed is the immediate application of pure carbolic acid followed by alcohol and the temporary packing of the wound with a piece of gauze saturated with a fifty per cent. solution of chloride of zinc, or, in suitable cases the use of the electric cautery. If possible the operation for removal should follow immediately after the diagnosis from the gross appearance and the frozen section.

This destruction is not essential in the bone cyst. Apparently in the giant-cell tumor it adds to the success of curetting. It apparently is life saving in the myxoma. The number of cures in periosteal and central sarcomas are too few to estimate the danger of exploratory incision without such destruction. Of the four cured cases (five years) two had pieces excised for diagnosis with an interval before amputation.

The present results of surgery for periosteal and central sarcomas do not offer very much. I am not prepared to discuss the results of *x*-ray, radium, and serum, but I can find no evidence that these agents have any effect upon the lung metastasis, and this is the cause of death.

Apparently the only hope rests on earlier recognition and proper intervention. *The disease must be eradicated locally before metastasis.*

In view of the frequency of benign periosteal and central

bone lesions and the small per cent. of cures in malignant lesions, any mutilating operation, such as amputation or extensive resection, is not justifiable until the diagnosis is accurately made. If there is any doubt as to the diagnosis of malignancy, the lesion should be treated as if it were benign.

In the past there is no question that many amputations and extensive resections have been done for benign lesions, especially the bone cyst and giant-cell tumor, and many surgeons have gotten a wrong impression as to the probabilities of a cure, because these patients have remained well with a diagnosis of sarcoma.

NOTE: The following illustrations have been reproduced from photographs made by Mr. Herman Schapiro.

Fig. 1. Path. No. 19133 (VII). Central Myxo-sarcoma. Greater tuberosity of humerus. See page 175.

Fig. 2. Path. No. 17871 (III). Benign bone cyst Trochanter Femur. See pages 168 and 175.

Fig. 3. Path. No. 7964 (X). Central Sarcoma. Upper end of Fibula. Plate taken many years ago, poor. See pages 166 and 176.

Fig. 4. Path. No. 12926 (V). Central Giant Cell Tumor. Upper end of Fibula. See pages 166 and 176.

Fig. 5. Path. No. 16297 (III). Benign Bone Cyst. Upper end of Tibia. See page 176.

Fig. 6. Path. No. 12276 (V). Central Giant Cell Tumor. Upper end of Tibia. See page 176.

Fig. 7. Path. No. 13092 (X). Central Sarcoma. Upper end of Tibia. Diagnosed Osteomyelitis. See page 177.

Fig. 8. Path. No. 3931 (X). Central Sarcoma. Upper end of Tibia. Showing perforation of cortical bone with formation of periosteal tumor. See page 178.

Fig. 9. Path. No. 9881 (V). Central Giant Cell Tumor, Inner Condyle Femur. See page 178.

Fig. 11. Path. No. 20115 (XIII). Malignant Central Bone Cyst. Outer Condyle Femur. See pages 172 and 179.

Fig. 10. Path. No. 9881 (V). Central Giant Cell Tumor. Inner Condyle of Femur. Photograph of specimen removed. See Fig. 9.

Fig. 12. Path. No. 20115 (XIII). Malignant Central Bone Cyst. Outer Condyle Femur. Gross Specimen. See Fig. 11. (Page 179.)

No. 13. Path. No. 20646 (III). Benign Bone Cyst. Lower end of Femur. (Huge size.) See pages 168 and 179.

Fig. 14. Path. No. 20209 (III). Benign Bone Cyst. Shaft of Femur (Huge). See page 180.

Fig. 15. Path. No. 22016 (II). Central Chondroma lower end of Femur. See page 180.

Fig. 16. Path. No. 25778 (V). Central Giant Cell Tumor. Lower end of Femur. See page 180.

Fig. 17. Path. No. 25778 (V). Central Giant Cell Tumor. Lower end of Femur. See page 180.

Fig. 18. Path. No. 23407 (VIII). Central Fibro-sarcoma. Lower end of Femur. See page 181.

Fig. 19. Path. No. 23407 (VIII). Central Fibro-sarcoma. Lower end of Femur. For x-ray see Fig. 18.

Fig. 20. Path. No. 14229 (XIII). Malignant Central Bone Cyst. Lower end of Femur. See pages 152 and 153.

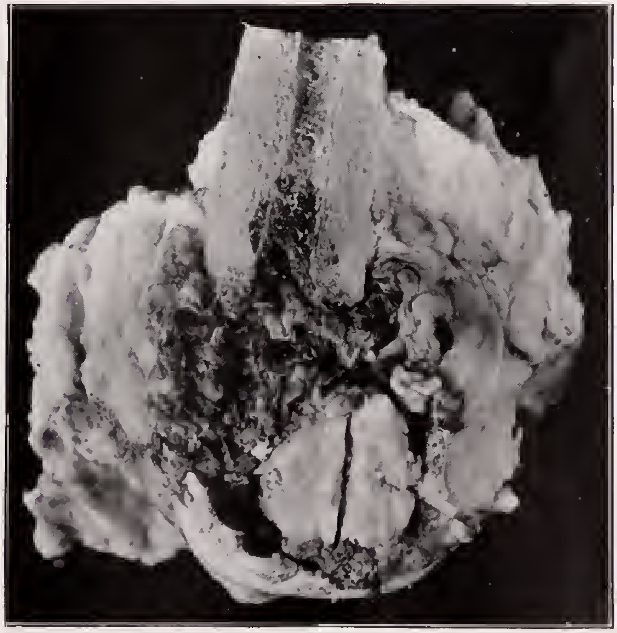

Fig. 21. Path. No. 14229 (XIII). Malignant Central Bone Cyst. Lower End of Femur. Gross Specimen. See Fig. 20 and page 154.

Fig. 22. Path. No. 23881. X-Ray of Bone Changes in Traumatic Arthritis. See page 154.

Fig. 23. Path. No. 19179 (XIII). Central Malignant Bone Cyst. Lower end of Femur. See page 182.

Fig. 24. Path. No. 19179 (XIII). Central Malignant Bone Cyst. Lower end of Femur. See Fig. 23.

Fig. 25. Path. No. 19179 (XIII). Central Malignant Bone Cyst. Lower end of Femur. Gross Specimen. See Figs. 23 and 24 and page 183.

Fig. 26. Path. No. 10602 (XIII). Central Malignant Bone Cyst. Shaft of Humerus. Pathological Fracture. See pages 151 and 171.

Fig. 27. Path. No. 10929 (III). Central Benign Bone Cyst. Shaft of Humerus. Pathological Fracture. Cured 10 years by removal of fluid only.

Fig. 28. Path. No. 22929 (II). Central Myxoma. Astragalus. Operation—Removal of bone piecemeal. See pages 155 and 156.

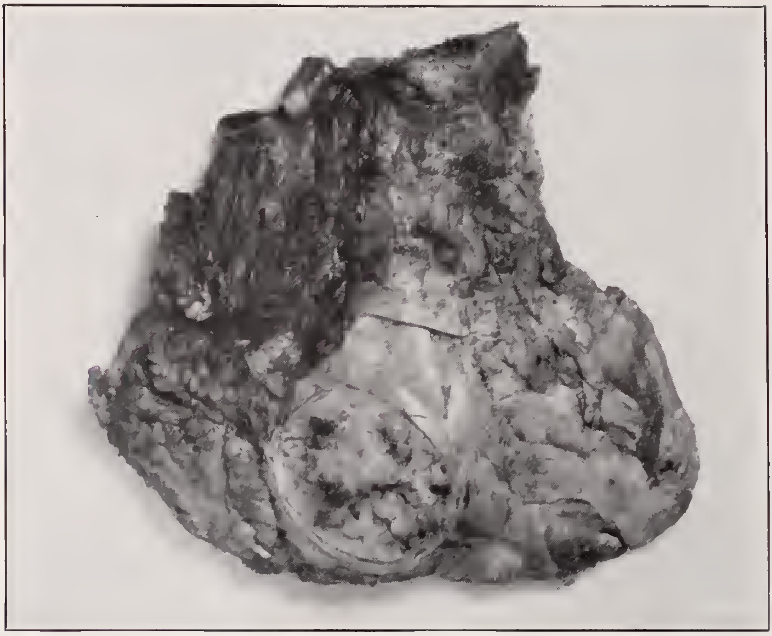

Fig. 29. Path. No. 22929 (II). Central Myxoma—Astragalus. Photograph of Gross specimen recurrent tumor after removal of Astragalus. See Fig. 28.

Fig. 30. Path. No. 22929 (II). Metastatic Myxoma Tubercle of Tibia after amputation of leg for recurrent myxoma in ankle joint. See Figs 28 and 29.

Fig. 31. Path. No. 17436 (V). Central Giant Cell Tumor. Os Calcis. Compare with Fig. 28. Patient of Dr. Prince, Rochester, N. Y. Curetted. Cured.

Fig. 32. Path. No. 24096 (III). Central Solid Ostitis Fibrosa. Shaft of Tibia. See page 163.

Fig. 33. Path. No. 24096 (III). Central Solid Ostitis Fibrosa. Shaft of Tibia. See Fig. 32.

Fig. 34. Path. No. 25542 (III). Central Solid Ostitis Fibrosa. Shaft of Tibia with evidence of bending and healing. See page 164.

Fig. 35. Path. No. 25109 (III). Central Solid Ostitis Fibrosa. Shaft of Tibia. Bending with evidence of ossification. Of interest because lesion present at birth. Operation at age 18 mos. Patient of Dr. Neil of Washington, D. C.

Fig. 36. Path. No. 21191 (III). Central Benign Bone Cyst. Lower end of Radius. See page 184.

Fig. 37. Path. No. 23552. Tuberculosis of lower end of radius and phalanx of index finger involving joint. See page 185.

Fig. 38. Path. No. 23895. Tuberculosis of internal malleolus of tibia. See page 185.

Fig. 39. Path. No. 12927. Central giant-cell tumor of lower end of radius. See page 185.

Fig. 40. Path. No. 16720 (V). Giant-cell tumor of lower end of radius. Marked expansion of bony shell. Patient of Dr. Sherman of San Francisco. Page 185.

Fig. 41. Path. No. 2420 (V). X-ray of giant-cell tumor of lower end of radius with complete destruction of bone shell. See Figs. 42 and 43. Page 185.

Fig. 42. Path. No. 2420 (V). Photograph of forearm the x-ray of which is shown in Fig. 41.

Fig. 43. Path. No. 2420 (V). Photograph of gross specimen. Giant-cell tumor of lower end of radius. For x-ray see Fig. 41.

Fig. 44. Path. No. 1815 (V). Photograph of specimen of giant-cell tumor of lower end of radius. Page 185.

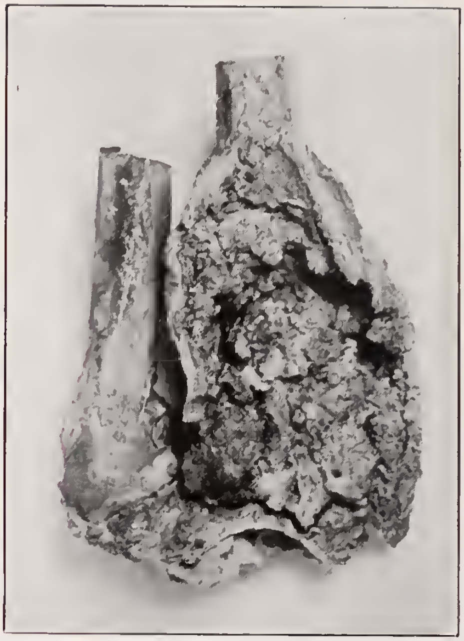

Fig. 45. Path. No. 6125 (V). Photograph of specimen of giant-cell tumor of lower end of radius.

Fig. 46. Path. No. 24682 (V). *X*-ray of giant-cell tumor of metacarpal bone of middle finger. Diagnosed sarcoma. Amputation. Page 187.

Fig. 47. Path. No. 24682 (V). Anteroposterior view of case shown in Fig. 46.

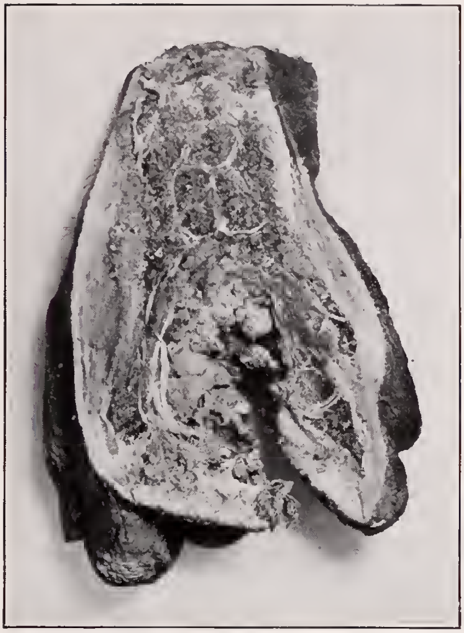

Fig. 48. Path. No. 24682 (V). Longitudinal section through hand. Giant-cell tumor, to demonstrate that the tumor could have been removed locally. See Figs. 46 and 47 for *x*-ray, and page 187.

Fig. 49. Path. No. 24682 (V). Photograph of gross specimen, surface view after removal of skin. See Figs. 46, 47, and 48.

Fig. 50. Path. No. 9025 (III). Benign bone cyst of upper end of ulna. Patient of Dr. Colvin of St. Paul, Minn. White female aged six years; swelling seven months. This *x*-ray was taken in 1904. For result (1920) see Fig. 51.

Fig. 51. Path. No. 9025 (III). *X*-ray (1920) fourteen years after *x*-ray shown in Fig. 50 demonstrating spontaneous healing of bone cyst without operation.

Fig. 52. Path. No. 17671 (XII). Central sarcoma of upper end of radius. Complete destruction of bone. The tumor shows a shadow. For gross specimen see Fig. 53. (Pages 178 and 183.)

Fig. 53. Path. No. 17671 (XII). Photograph of gross specimen. For x-ray see Fig. 52. White female aged sixty-five; pain six months; swelling six weeks.

Fig. 54. Path. No. 6367 (I). Benign exostosis of ilium. No operation. Recovery. See page 191.

Fig. 55. Path. No. 23886 (I). Benign exostosis of phalanx. See page 191.

Fig. 56. Path. No. 10150 (I). Diagnosed benign exostosis of femur. Removed piecemeal. Myxoma found mixed with cancellous bone. Local recurrence and death. See pages 190 and 191.

Fig. 57. Path. No. 25766 (II). Periosteal osteochondroma of shaft of femur. See page 192.

Fig. 58. Path. No. 6773 (II). Periosteal myxoma of shaft of humerus. Compare with Fig. 59, see page 193.

Fig. 59. Path. No. 10693 (III). Benign bone cyst of lower end of fibula. X-ray suggesting periosteal myxoma. Compare with Fig. 58. See page 194.

Fig. 60. Path. No. 10693 (III). X-ray after operation. (See Fig. 59.)

Fig. 61. Path. No. 10693 (III). Photograph of specimen. Benign bone cyst showing zone of healthy tissue about the tumor. See Figs. 59 and 60.

Fig. 62. Path. No. 15557 (IX). Periosteal sarcoma of lower end of femur. See page 196.

Fig. 63. Path. No. 15557 (IX). Lateral view. (See Fig. 62.)

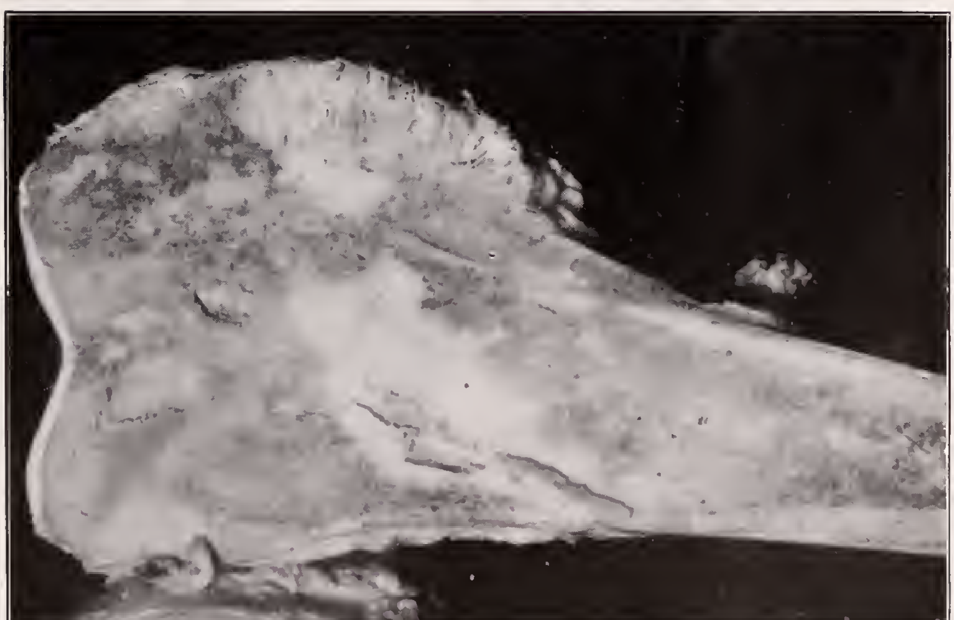

Fig. 64. Path. No. 15557 (IX). Gross specimen of case shown in Figs. 62 and 63.

Fig. 65. Path. No. 25761 (IX). Periosteal sarcoma of neck of femur. See page 197.

Fig. 66. Path. No. 25761 (IX). Periosteal sarcoma. For x-ray see Fig. 65.

Fig. 67. Path. No. 24428 (IX). Periosteal sarcoma of upper end of fibula. See page 198.

Fig. 68. Path. No. 24428 (IX). Gross specimen. For x-ray see Fig. 67. Fibula surrounded by periosteal growth.

Fig. 69. Path. No. 22795 (IX). Periosteal sarcoma of lower end of femur. See page 198.

Fig. 70. Path. No. 23284 (IX). Periosteal sarcoma with excessive bone formation, suggesting ossifying myositis. See pages 193 and 199.

Fig. 71. Path. No. 10537 (IX). Periosteal sarcoma of upper third of tibia. Diagnosed osteomyelitis and syphilis. See page 200.

Fig. 72. Path. No. 15745 (IX). Periosteal sarcoma of upper end of femur, resembling osteomyelitis. See page 200.

Fig. 73. Path. No. 23894 (IX). Periosteal sarcoma of upper end of tibia. Diagnosed osteomyelitis. See page 201.

Fig. 74. Path. No. 23894 (IX). Periosteal sarcoma of upper end of tibia. Gross specimen. For *x*-ray see Fig. 73.

Fig. 75. Path. No. 25505 (IX). Periosteal sarcoma of lower end of femur. No *x*-ray evidence of periosteal tumor, only of the marrow invasion. See page 201.

Fig. 76. Path. No. 14817 (IX). Periosteal sarcoma of shaft of humerus. Practically no periosteal bone formation, only destruction of shaft. For gross specimen see Fig. 77.

Fig. 77. Path. No. 14817 (IX). Photograph of gross specimen in case shown in Fig. 76. White male aged twenty-one; pain and swelling five months.

Fig. 78. Path. No. 10313. Traumatic ossifying periostitis of shaft of humerus and clavicle. Diagnosed periosteal sarcoma. See page 202.

Fig. 79. Path. No. 11769. Syphilitic periostitis of lower end of ulna. For x-ray see Fig. 80. Diagnosed sarcoma. See page 204.

Fig. 80. Path. No. 11769. Syphilitic periostitis of lower end of ulna. Diagnosed sarcoma. See Fig. 79.

Fig. 81. Path. No. 16865. Infectious ossifying periostitis of upper shaft of femur. Diagnosed periosteal sarcoma. Refused operation. Recovery. For result see Fig 82, and page 205.

Fig. 82. Path. No. 16865. Result in case shown in Fig. 81.

Fig. 83. JCB No. 8415. Subacute osteomyelitis of ulna, suggesting periosteal sarcoma or syphilis. Compare with Figs. 73 and 80. See page 207.

Fig. 84. Path. No. 24311. Tuberculosis of metacarpo-carpal joint with ossifying periostitis of shaft of metacarpus. See page 207.

Fig. 85. Path. No. 24367. Bone formation in joint capsule associated with enchondroma of joint. See page 208.

Fig. 86. Path. No. 23323. Destruction of frontal bone associated with benign periosteal tumor. See page 208.

Fig. 87. Path. No. 25888. Periosteal sarcoma of lower end of femur with much bone destruction and early metastasis to lung (see Fig. 88 and page 148.

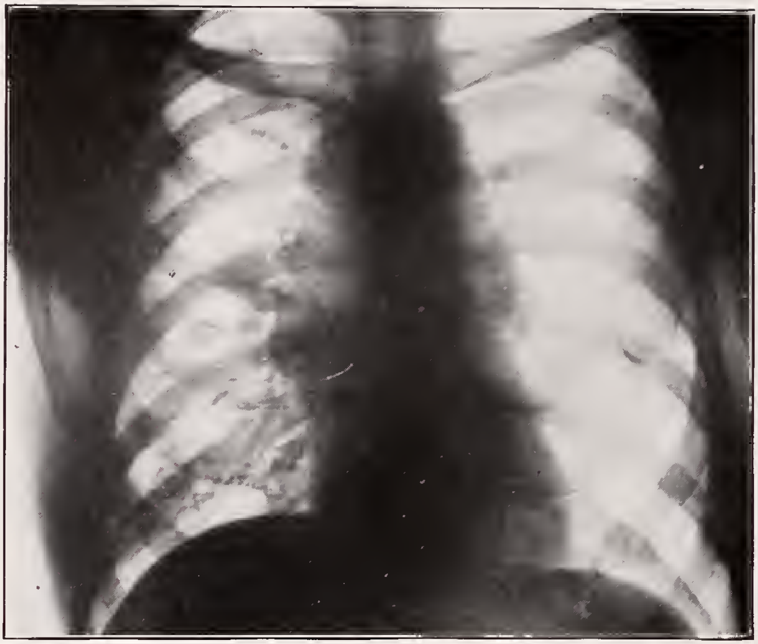

Fig. 88. Path. No. 25888. *X*-ray of chest showing metastasis from periosteal sarcoma of femur, shown in Fig. 87. See page 148.

Fig. 89. Path. No. 25656 (III). Benign Central Solid Ostitis Fibrosa, shaft of humerus, pathological fracture. See text, page 161. Compare with Fig. 32, Path. No. 24096. Similar type of tumor shaft of tibia, no fracture. See text, page 163.

THE BONE NUMBER

Volume One, Number Three, of the Journal of Radiology, appearing with this issue, contains a most valuable contribution.

"The Diagnosis and Treatment of Benign and Malignant Tumors of Bone," by Joseph Colt Bloodgood, M. D., Professor of Surgery, Johns Hopkins University, Baltimore, comprises the entire number.

This paper deals with a subject that at the present time is under much discussion by pathologists and surgeons, and Dr. Bloodgood's work has gone far in clearing the atmosphere and gives us an excellent conception of bone tumors.

This contribution will be found to be of the greatest value to every medical man, be he surgeon, pathologist, roentgenologist, or internist. It should be read most carefully.

It is the intention to publish in another number within the very near future the end results obtained in the diseases dealt with in this paper.

THE JOURNAL OF RADIOLOGY

PUBLISHED EVERY MONTH AT IOWA CITY, IOWA

THE JOURNAL OF RADIOLOGY is the official publication of the Radiological Society of North America, and is published monthly under the authority of the Society.

Subscription prices, per annum in advance, including postage: Domestic, $5.00; Foreign, $6.50.

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MEETINGS: The Radiological Society meets semi-annually. The annual meeting is usually held during the month of December.

Entered as second-class matter January 17, 1919, at the Post Office at Iowa City, under the Act of March 3, 1879.

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The
JOURNAL *of* RADIOLOGY

Published by the Radiological Society of North America

Volume I April, 1920 Number 4

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ANNUAL MEETING
THE RADIOLOGICAL SOCIETY

December 15, 16, 17, 1920
Chicago

The next annual meeting of the Radiological Society will be held in Chicago, December 15, 16, and 17, 1920. Headquarters—Hotel Sherman.

The committee on local arrangements are: Dr. B. H. Orndoff, Chairman; Dr. Mary Hanks, Dr. Maximilian J. Hubeny, 25 E. Washington St.

Committee on Commercial and Plate Exhibit: Dr. I. S. Trostler, Chairman, 615 Garfield Ave.

The executive committee of the Society wishes to announce that owing to the difficulty arising from the constant shortage of hotel facilities in Chicago, they have assured the hotel management that they would endeavor to have the members and guests make reservations as far in advance of the dates of the meeting as possible. If this matter is attended to promptly, a great deal of confusion will be avoided.

The program committee wishes to announce that they have under way the arrangement of a program embodying some new and very interesting features together with the usual scientific sessions and social functions.

ROENTGENOLOGY OF TUBERCULOUS ENTEROCOLITIS*

R. D. Carman, M. D.
Section on Roentgenology
Mayo Clinic, Rochester, Minn.

The early symptoms of ulcerative tuberculous colitis are not sufficiently characteristic to make possible a definite clinical diagnosis, even in the presence of pulmonary tuberculosis. If any benefit is to come from treatment it is imperative that the disease be recognized early, and for this recognition the roentgen ray furnishes the most certain means as yet available. A positive and independent roentgen diagnosis of tuberculous colitis is difficult, however, for there are no pathognomonic roentgen signs, as the filling defect and the absence of the normal barium shadow in the cecocolon are signs of any ulcerative lesion. Even the finding of *Bacillus tuberculosis* in the stool is of no value in determining the nature of the lesion in the intestine unless a tuberculous lesion in the lungs or *Bacillus tuberculosis* in the sputum can be excluded. Every patient with indefinite abdominal complaint should, therefore, have a complete roentgenologic and general clinical examination. Tuberculosis has such a predilection for the ileocecal coil that a lesion in this part of the intestine, especially if associated with pulmonary tuberculosis, is most likely tuberculosis. Distal segments of the colon are seldom invaded; the disease almost always involves the proximal portion, especially the small bowel, ileocecal valve, cecum, appendix, and ascending colon (Brunner). Necropsies have demonstrated that from 70 to 90 per cent of persons suffering with ad-

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*Presented before the Omaha Roentgen Society, Omaha, March 27, 1920. Published in part in the *Journal of the American Medical Association*, Volume 74, No. 20, May 15, 1920, page 1371.

vanced pulmonary tuberculosis have tuberculosis of the intestine.

In reviewing the physiology of the colon, the following facts should be kept in mind for a better understanding of the abnormal colon: The cecum and ascending colon form a pouch-like expansion of the proximal part of the large bowel. Their walls are thinnest and therefore weakest and capable of great distention. The interior depressions of the cecum correspond with the surface haustra. It is definitely known that food remains in this portion of the colon longer than in any other, and it is thought that this delay is largely due to haustration and antiperistalsis. With these physiologic functions in mind, it is not difficult to understand how their loss by disease explains the emptiness and gap in the physiologic barium shadow seen in ulcerative diseases of the colon. The bowel contents pass with abnormal rapidity, because the normal functions which retard the physiologic progress are absent.

Pathology of Tuberculosis of the Intestine

The pathology of tuberculosis of the intestine may conveniently be divided into three types: (1) Nodular, (2) ulcerative, and (3) fibrous.

In the nodular type the lesion is made up of conglomerate tubercles which are principally extralumenal in their earliest stages. The nodules are not infrequently seen alone, apparently unaccompanied by tuberculosis elsewhere; they may rarely be seen in association with chronic ulcerative tuberculous ileocolitis, and in such case may be the sequel of pulmonary tuberculosis. This type can hardly be recognized roentgenologically unless it produces obstruction or encroaches on the lumen of the bowel.

The ulcerative type is frequently associated with the nodular, but in a typical instance ulcerative tuberculous colitis is the primary lesion. However, it is possible for tuberculosis to be associated with it in other parts of the body. This type is evidenced by irregularity of bowel contour in the roentgenogram; in the terminal stages it produces obstruction.

The fibrous or hypertrophic type of tuberculosis is manifested by a marked increase of fibrous connective tissue; the tubercles are discrete and relatively sparse. The large amount of fibrous tissue indicates a marked resistance on the part of the individual. It is the terminal stage of healing tuberculous colitis and pericolitis. This type gives practically the same roentgen picture as the ulcerative.

Technic of Examination

The technic of the examination is not difficult. In fact, it is the same as is used for all other diseases of the intestine. In the Mayo Clinic the enema is ordinarily employed; when necessary the ingested meal is used; in a few cases both methods may be necessary. The enema is preferable since it demonstrates small irregularities of contour by actually outlining the bowel wall, whereas the ingested meal is so unevenly distributed throughout the normal bowel that its irregularity cannot be distinguished from that due to disease. This is especially true in cases in which there is little involvement. If the enema is employed, the colon is filled under observation up to and including the cecum. If the ingested meal is given, observations of the intestine with the screen are made at intervals from the sixth to the eighteenth hour. Roentgenograms are made as a matter of record and for study.

Roentgenologic Signs of Tuberculous Colitis

The roentgenologic signs of tuberculous colitis are: (1) Filling defects; (2) spastic phenomena, and (3) obstruction.

The first and most important roentgenologic sign of tuberculous ileocecal colitis is the filling defect, which is due to the ravages of the disease plus spastic manifestations. It is best seen during the screen examination with the opaque enema. Under pressure of the enema the cecum and ascending colon are seen to fill irregularly and are de-

cidedly narrowed in their transverse diameter. The normal haustral markings are absent and Bauhin's valve is usually incompetent. After the pressure of the enema is relieved by shutting off the flow, the involved area usually empties and remains emptied while the remainder of the colon may retain the enema for some time.

The filling defect and the localized absence of barium shadow in the cecum and ascending colon are not entirely characteristic of tuberculous colitis; I have seen them in ulcerative carcinoma of the cecum and chronic ulcerative colitis. Stierlin has reported a case of carcinoma in the ileocecal coil with similar findings. Nevertheless, a lesion of the cecum and ascending colon without the physiologic barium shadow should always suggest the possibility of tuberculosis, and tuberculosis should be looked for in other parts of the body, particularly the lungs. If tuberculosis can be definitely demonstrated in the lungs, the lesion of the cecocolon, whether there is an absence of the physiologic barium shadow or not, is most likely tuberculous colitis.

Hypermotility has been emphasized by Brown and Sampson as an important roentgenologic sign of tuberculous colitis. The term hypermotility can hardly be applied to this phenomenon because, strictly speaking, hypermotility refers to the passage of bowel contents, at an increased rate, along the entire alimentary canal as is often seen in diarrhea and achylia. Fifty per cent of our patients with tuberculous colitis suffered from constipation or delayed motility. In the more advanced cases with diarrhea hypermotility was noted. The gap in the barium shadow, I believe, does not represent hypermotility, but is the effect of diffuse infiltration of the bowel wall which produces rigidity of the part of the intestine affected. It is apparent from this that the physiologic functions of the diseased segment of the colon have been lost and the barium passes through it without hindrance, just as it does through a stomach diffusely infiltrated with cancer. In the absence of diffuse infiltration, spasm stiffens the walls giving the same motoric effect.

Béclère and Mériel state that an ulcerated mucosa manifests its irritability by an exaggeration of muscular peristalsis with an abnormally rapid progress of the contents of the intestine. I have never observed this muscular peristalsis, but I have seen marked spasm of the musculature of the colon due to irritability from an ulcerated mucosa, and I am inclined to think that Béclère meant spasm when he said peristalsis. Stierlin is evidently of the same opinion for in discussing the same subject he mentions no acceleration of motility. Indeed, it has been demonstrated in operations, when the patient is under the influence of narcosis, that this spasmodic condition does exist and its extent is in proportion to the extent of the lesion. For example, if a small solitary lesion is present the spasm is localized and may be analogous to the incisura seen in gastric ulcer. In this early stage of the disease usually there is no gap in the barium shadow of the ingested meal, but the irregularity of contour due to spasm may be visualized by the opaque enema even if the lesion is not demonstrable.

Stierlin, in 1911, first pointed out the absence of a physiologic barium shadow in the cecum and ascending colon in tuberculosis of the ileocecal coil. Much to his surprise, at a time when normally he expected to show the cecum and ascending colon in the roentgenogram, no shadow was visible; in its advance the shadow seemed to skip the cecum and the ascending colon. In this country Pirie was the first to notice this phenomenon. By observations at half-hour intervals, continued for from four to twelve hours, he was able to prove that the tuberculous cecum does not retain the barium which normally accumulates there.

Spasm is a manifestation which to a greater or less degree accompanies many if not all gastro-intestinal lesions. It is one of the most perplexing conditions with which the roentgenologist has to deal. For instance, lesions so slight as to cause no irregularity of contour demonstrable in the roentgenogram may exhibit marked deformity and narrowing due to spasm. Indeed, the absence of barium from an

involved area of the bowel is caused usually by spasm and infiltration of the intestine rather than by hypermotility. This type of spasm is intrinsic in origin and constant in situation; it is present at a second examination and cannot be effaced by antispasmodics.

In our cases tuberculosis has been more frequent in the small than in the large bowel. The lesions are seen most often in the ileum and the jejunum, but the latter is less frequently affected. They occur in the bowel anywhere from a few inches to one foot or more apart and usually become confluent near the ileocecal valve. The affected areas are not more than one-half to three-quarters of an inch in width. They are slightly elevated, may or may not be studded with tubercles, and involve the entire circumference of the intestine. Palpation of the areas reveals the presence of ulcers in the mucosa.

The roentgen diagnosis of tuberculous enteritis is less certain than that of tuberculous colitis. This is probably due to the physiologic and anatomic difference between the small and the large intestine. The obstruction which is occasionally noted is not characteristic, for it is observed in other pathologic conditions. However, I have observed another sign which may have diagnostic value, namely, delay with irregular filling and segmentation of the small bowel; but further study will be necessary to establish this fact.

Summary

A lesion roentgenologically demonstrated in the ileocecal coil, with irregularity of bowel contour and without the physiologic barium shadow in the cecocolon, although it may represent any ulcerative process, is probably tuberculous if pulmonary tuberculosis is present.

The tuberculous lesions may be nodular, ulcerative, or fibrous; they are usually associated to a greater or less extent, dependent on the stage of the disease. The nodular type is recognized by means of the roentgen ray only if it

encroaches on the lumen of the bowel, and the ulcerative and fibrous types by irregularity of contour, and in the terminal stages by obstruction.

The presence of spasm must not be overlooked since it often causes irregularity of contour and is diagnostic even when the lesion itself is not demonstrable.

The opaque enema generally is preferable to the ingested meal in demonstrating the filling defect and spastic phenomena which are roentgenologic signs of tuberculous colitis. In tuberculosis of the small bowel the ingested meal only can be used. A gap in the physiologic barium shadow of the cecocolon in the more advanced cases is demonstrated by the ingested meal, but unquestionably the disease will be demonstrated earlier by the enema.

REFERENCES

1. Béclère et Mériel: L'exploration radiologique dans les affections chirurgicales de l'estomac et de l'intestin. Rapport 25 Congrès Français de Chirurgie, Paris, 1912, 103 pp.
2. Brown, L., and Sampson, H.: The early roentgen diagnosis of ulcerative tuberculous colitis. Jour. Am. Med. Assn., 1919, lxxiii, 77–85.
3. Brunner, C.: Tuberculose, Aktinomycose, Syphilis des Magen-Darmkanals. Stuttgart, Enke, 1907, 399 pp.
4. Pirie, H. Quoted by Archibald, E.: The role of surgery in the treatment of intestinal tuberculosis. The National Association for the Study and Prevention of Tuberculosis, 1917, 117–134.
5. Stierlin, E.: Die Radiographie in der Diagnostik der Ileozoekaltuberkulose und anderer Krankheiten des Dickdarms. Münch. med. Wchnschr., 1911, lviii, 1231–1235.

Illustrative Cases

Case 285818.—A woman, aged 20, in 1918 had had fever, cough, night sweats, loss of weight, weakness, and pain in the abdomen; no diarrhea.

X-ray Findings.—August 23, 1915. Pulmonary tuberculosis with compression of the left lung. Stomach negative. Colon: irregularity and narrowing of the ileocecal coil (Fig. 1).

Surgical Findings.—Intestinal tuberculosis. There was

a tumor mass in the cecum and the entire length of the ileum was studded every three to six inches with tuberculous nodules, some of them producing slight obstruction.

Operation.—Closed as exploration.

Case 276488.—A man, aged 36, had general abdominal pain, commencing two years before examination, lasting from five to six hours at a time, and relieved by bowel movements. Appendectomy was done elsewhere in September, 1918. Very severe attack came on six weeks after the operation with nausea and vomiting. By dieting he was free from pain until May, 1919, then intermittent diarrhea and constipation. Pain not localized, and relieved by bowel movements.

X-ray Findings.—June 23, 1919. Pulmonary tuberculosis. Stomach negative. Colon: filling defect in the cecum, narrowing and irregularity with eighteen-hour retention in the terminal ileum (Fig. 2).

Surgical Findings.—Tuberculosis of the cecum and ileum.

Operation.—Resection of the right half of the colon with twelve inches of the ileum.

Pathologic Report.—Tuberculous ulcer of the ileum 8 cm. from the ileocecal valve.

Case 161981.—A man, aged 28, had had an appendectomy elsewhere in 1913. A tumor was removed from the cecum, elsewhere, in 1914. Previous to the first operation the patient had three attacks of pain in the right lower abdomen with nausea. After operation he was relieved for eleven months. In 1915 he had attacks of pain, distention, nausea, and vomiting, at first from one to three weeks, now every day. Tumor mass in the right iliac fossa for six months.

X-ray Findings.—June 7, 1916. Pulmonary tuberculosis. Stomach negative. Colon: filling defect in the cecum (Fig. 3).

Surgical Findings.—Large tuberculous tumor of the cecum, involving about one foot of the ileum.

Operation.—Resection of the right half of the colon.

Pathologic Report.—Tuberculosis.

Case 77400.—A woman aged 38, had had pain in the abdomen with vomiting for a long time and almost constantly for the last four months.

X-ray Findings.—October 13, 1913. Small bowel, markedly dilated, indicating intestinal obstruction (Fig. 4).

The patient returned ten months later, with the same symptoms as before; she had had diarrheas for the past three months. The *x*-ray findings were the same as before.

Surgical Findings.—Localized tuberculosis involving upper jejunum about six feet from its origin.

Operation.—Resection of twelve inches of the upper jejunum, anti-peristaltic lateral anastomosis.

Pathologic Report.—Tuberculosis (Fig. 5).

The patient returned in 1917, at which time the examination revealed pulmonary tuberculosis.

Case 311436.—A man aged 28, had had an attack of pleurisy four years before examination. He was well until the fall of 1919, when he developed a morning cough accompanied by prostration. Three weeks later he commenced to have two loose foul smelling bowel movements daily with colicky pain in the lower abdomen relieved by bowel movements.

X-ray Findings.—April 7, 1920. Pulmonary tuberculosis with cavitation. Stomach negative. Colon, filling defect in the cecum (Fig. 6).

Clinical Findings.—Pulmonary tuberculosis and intestinal tuberculosis. The lung involvement was considered too extensive and active for surgery.

Case 161810.—A man, aged 37, for the last eight months had had tenderness in the lower abdomen, gradually becoming localized on the right side. Constipation was becoming more marked. A small palpable mass in the region of the cecum was explored elsewhere, and a diagnosis of carcinoma was made.

X-ray Findings.—June 6, 1916. Filling defect of the cecum (Fig. 7).

Surgical Findings.—Tuberculosis of the cecum.

Operation.—Resection of the right half of the colon.

Pathologic report.—Tuberculosis.

Case 282377.—A man, aged 21, began to lose weight after influenza in July, 1918. In February, 1919, he had a hemorrhage from the intestine. One month later he had pain in the lower abdomen, one attack each week until June, when it became constant. Diarrhea commenced in July, from six to eight stools daily. There was general diffuse tenderness over the lower abdomen, more marked on the right side.

X-ray Findings.—August 5, 1919. Chest and stomach negative. Filling defect on the inner and the outer aspects of the ascending colon (Figs. 8 and 9).

Surgical Findings.—Tuberculosis of the cecum and ascending colon; tuberculous lesion of the lower end of the ileum.

Operation.—Resection of three feet of the ileum, entire cecum, and ascending colon, and half of the transverse colon.

Pathologic Report.—Tuberculosis.

Case 268368.—A woman, aged 50, had had a tumor of the intestine excised elsewhere in September, 1918.

X-ray Findings.—April 25, 1919. Chest and stomach negative. Filling defect in the cecum (Fig. 10).

Surgical Findings.—Tuberculosis of the cecum and terminal ileum.

Operation.—Resection of the ileocecal coil.

Pathologic Report.—Tuberculous ulcers in the mucosa of the cecum and terminal ileum.

Case 310140.—A man, aged 21, began to have trouble two months before with diarrhea, cramps, fever and cough. Tuberculosis bacilli were found in the sputum. Pain in the abdomen occurred about half an hour after eating; he had diarrhea (from two to three watery movements daily).

X-ray Findings.—March 25, 1920. Pulmonary tuberculosis with cavitation. Stomach, negative. Colon, filling defect in the cecum and ascending colon (Fig. 11).

Clinical Diagnosis.—Pulmonary and intestinal tuberculosis, involvement too extensive for surgery.

Case 253143.—A man, aged 25, eight months before examination had developed pain from one-half to one hour after eating, which was relieved by vomiting.

X-ray Findings.—December 14, 1918. Stomach, six-hour retention with marked dilatation and writhing of the duodenum. Obstruction high in the jejunum (Figs. 12 and 13).

Surgical Findings.—Large mass of caseating tuberculous glands obstructing the third portion of the duodenum.

Operation.—Posterior gastro-enterostomy.

Pathologic Report.—Tuberculous glands.

Case 283098.—A woman, aged 28, had had an appendectomy in 1916. Five years before, this abdominal pain with vomiting and at times diarrhea had occurred.

X-ray Findings.—August 9, 1919. Pulmonary tuberculosis with cavitation. Stomach negative; colon, filling defect in the cecum and ascending colon. Absence of a physiologic barium shadow in the cecocolon (Figs. 14 and 15).

Surgical Findings.—Tuberculosis of the cecum and ileum. Scattered throughout the entire ileum at intervals of from five inches to one foot were areas indicative of tuberculosis of its mucosa, producing slight narrowing. Because of the extent of the lesion resection did not seem indicated.

FIG. 1. (Case 285818.) Tuberculosis of the ileocecal coil. Irregularity of cecum and ascending colon at "a".

FIG. 2. (Case 276488.) Filling defect in the cecum, narrowing and irregularity of the terminal ileum at "a".

FIG. 3. (Case 161981.) Filling defect in the cecum at "a".

FIG. 4. (Case 77400.) Small bowel markedly dilated. Small six-hour retention in the stomach.

FIG. 5. (Case 77400.) Specimen same case as Fig. 4. Fibrous tuberculosis of the jejunum

Fig. 6. (Case 311436.) Filling defect in the cecum at "a".

FIG. 7. (Case 161810.) Filling defect in the cecum at "a".

FIG. 8. (Case 282377.) Filling defect, outer aspect of the ascending colon at "a".

FIG. 9. (Case 282377.) Same case as shown in Figure 8. Second examination. Filling defect inner aspect of the ascending colon at "a".

Fig. 10. (Case 268368.) Filling defect in the cecum at "a".

Fig. 11. (Case 310140.) Filling defect in the cecum at "a".

FIG. 12. (Case 253143.) Obstruction of the third portion of the duodenum at "a".

Fig. 13. (Case 253143.) Same case as shown in Figure 12, reverse peristalsis of the duodenum.

FIG. 14. (Case 283098.) Filling defect in cecum and ascending colon at "a".

FIG. 15. (Case 283098.) Same case as shown in Figure 14. Absence of physiologic barium shadow, cecocolon at "a".

X-RAY TREATMENT OF MALIGNANCY

A. P. Overgaard, M. D.
Omaha

Upon the introduction of the Coolidge tube, early in 1914, we began to use aluminum and sole leather to filter out the alpha and beta rays which had been causing our burns. Deeper penetration was sought and new transformers were built especially for deep therapy work. These gave us a ten-inch spark instead of the old seven-inch.

This added penetration was the most important development of the new tube for by careful cross-fire methods we could now deliver a full dose of rays where we wanted them.

Today, I am using a nine-and-one-half-inch back-up spark with five millimeters of aluminum and sole leather at a focal distance of eight inches and run six milliamperes current. This gives an erythema dose in eight minutes.

As a rule, we give three erythema doses in one day and require four to five days to cover a chest thoroughly. After such a complete ray, the patient is sent home for three weeks with orders to rest and keep on a light diet. She should, preferably, be in bed for a least a week after each series.

This system of applying the ray to a post-operative breast cancer case is repeated at least three times and if any signs of metastasis are then found, a fourth or fifth series is given. Then the patient is ordered to report at least once every three months for two years for an examination by fluoroscope to check up the lungs and mediastinum.

It is practically impossible to remove all the glands in the tissues by operation. These missed glands cause recurrence. Every cancer cell not removed is bound to grow again. So we need to be very thorough in our treatment.

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*Presented before the Omaha Roentgen Society, Omaha, March 27, 1920.

To produce the required effect in some cases enormous doses must be used.

Rare cases may require less. It depends upon the patient. The ray has a different effect on each one. I have found that a few could take two or three times an erythema dose and get only a slight reaction. Others get a marked reaction from an eight-minute dose.

Iodine used on the skin before the application of the ray will produce a severe reaction at once. Therefore it should never be used when a treatment is to be given. Always bear this in mind when a case presents itself for treatment immediately after operation.

The question of reaction is a serious phase of the practice of deep therapy. Constitutional effects must be recognized and then alleviated when possible. Baclere in a discussion of the effects of roentgen and radium therapy uses the term "Penetrating-Irradiations-Sickness" to include disturbances caused by the two agents, since they are practically the same, although symptoms vary in patients and at different times in the same patient.

Sickness produced by deep roentgen therapy ranges from general discomfort and languor lasting a few minutes or a few days, to loss of appetite and violent vomiting with nausea lasting as long as two weeks. These symptoms may come on at once or not until the next day. Women suffer more from this cause than men.

Reasons for the sickness are still obscure. However, the more completely gases are eliminated from the treatment room and absolutely pure, fresh air provided, the more the symptoms are reduced. In our office, a special fan is installed in the wall to exhaust the impure air. The patient's face is covered with a leaded rubber apron as is also the chest and abdomen not undergoing treatment at the time.

The inhalation of gases produced by the action of high tension wires upon the air must be largely responsible for the constitutional by-effects of the ray since the operator and his assistants are often similarly affected. However,

this hypothesis is denied by Jones, Ewing, and others who believe that nausea results only when the breast or the lower part of the chest is treated with large doses. Roth attributes the by-effects to an irritation of the vagus nerve.

The feeling of dryness in the mouth, excessive thirst, the presence of a brassy taste, and the change in the flavor of foods indicate that the salivary glands and others in their region are affected. The *x*-rays have been found also to affect the ganglionic sensory nervous system which might account in part for the condition as it resembles drunkenness or sea-sickness.

Such reflex symptoms are known to occur at times through the vascular system when arterial blood becomes loaded with a substance such as tartar emetic. The novice's first cigar may thus produce nausea and vomiting. When the sickness is delayed until the day after the treatment, by-effects may be the result of the formation of emetic substances gradually passing into the blood.

Whatever its cause, the penetrating-irradiations-sickness prevails in spite of all precautions and will probably increase with the increased use of the Coolidge tube. The intenser radiation and greater penetration of these otherwise superior tubes and the dosage possible with them cause a much more rapid and massive cellular destruction and consequently greater adulteration of the blood by toxic substances.

Russell H. Boggs laments the inadequate therapy given by a large majority of roentgenologists in the post-operative treatment of carcinoma of the breast. "First," he says, "they leave many chains of lymphatics untreated. And second, while they give a physiologic dose superficially, in cross-firing they employ too few ports of entry, so that as a result the deep tissues receive only one-third to one-seventh the physiological dose."

Every roentgen therapeutist should make a comprehensive study of the lymphatics draining the breast before he attempts to treat mammary carcinoma. The lymphatic

supply to the breast is greater than to almost any other organ and we learn from the study of bone metastases how extensively the lymphatics become involved. From this, we realize that when we ray only the line of incision, axilla, and supraclavicular region, our treatment is very incomplete. We should never neglect to ray the internal mammary glands, since it is from these that the involvement from one breast to the other takes place.

Autopsy has shown that the liver of all internal organs is the most frequent seat of metastases and often becomes involved in quite early stages. Handley attributes this to cancerous dissemination along the lymphatics of the fascia of the thoracic wall to the epigastrium and the umbilicus, whence these cells follow the lymphatics and are deposited on the surface of the liver or are carried on to the portal glands.

Next in freqnency to be involved are the lungs, pleura, and glands of the mediastinum. The intercostal lymphatics are responsible here. Next comes the pelvic viscera, involved in about eight per cent of early cases in young patients and in four per cent of older patients. To account for the lower percentage, we again look to the lymphatics which with age undergo senile atrophy.

Overwhelming evidence proves the lymphatics to be the chief agent of cancer dissemination. In the aged and in thin patients where the vessels are smaller, the advance of metastases is less rapid. If the roentgen rays did nothing more than produce a sclerosis of the lymphatics and a reduction of the size of the vessels, the treatment would at least check the progress of the disease and in some cases effect a cure.

In view of the wide distribution and depth of metastases, we know that in treating carcinoma of the breast the rays must be so directed that the deep glands in the axilla, under the clavicle, in the mediastinum, those leading to the liver, and all the viscera which invite metastases through the lymphatics will receive a full roentgen dose employed so

that the deep glands will be given from three to seven times the amount that is given to any skin areas.

Pfahler in a recent article on Malignant Disease of the Lungs advances the theory that when the lungs are involved it must always be looked upon as a part of a general carcinomatosis and treated as such. His conclusions are,

1. Primary malignant disease of the lung is rare.
2. Metastatic malignant disease of the lung is common and should always be looked for in connection with advanced malignancy.
3. A roentgenological examination of the chest should be made in every case of carcinoma of the breast referred for operation or roentgenotherapy and he would look to an earlier recognition of the disease.

For, more and more, we realize that best results come only when the ray is applied early. On an open wound it is productive of rapid healing and the more quickly it is applied to the parts which may still retain cancer cells, the better. I recommend the first treatment within a week after operation or as soon as the effects of the anesthetic are past. This is the only safeguard against recurrence.

I am convinced from the cases I have seen during the past five years that proper post-operative treatment will now prevent from twenty-five to fifty per cent of recurrences even in early cases, because cancer cells can be destroyed at a greater depth and distance from the original growth. And I agree with Deaver that it is only a question of time until the profession will realize that post-operative treatment is just as necessary after the operation as is asepsis before and during the operation.

Have seen splendid palliative results from radiation and find no cause for discouragement as an encouraging number are living today and show no recurrence.

In closing I shall review, briefly, with lantern slides ninety typical cases treated and their results. The majority of these cases came to me for treatment within a month following operation.

NO.	SEX	AGE	DISEASE	HISTORY	DATE OF TREATMENT	RESULTS
1.	Female	53	Breast cancer	Post-operative	July, 1915	Died April, 1917, of typhoid
2.	Female	35	Breast cancer	3rd operation in 2 yrs.	July, 1915	Died 5 mo. later, general metastasis
3.	Female	46	Breast cancer	Post-operative	July, 1915	Died April, 1916; apoplexy, no recurrence
4.	Infant	11m.	Sarcoma eye	1 mo. duration	July, 1915	Died; no improvement
5.	Female	50	Breast cancer	Post-operative	Jan., 1916	Jan., 1918, slight recurrence; living and well
6.	Male	27	Sarcoma of testicles	2nd operation 2 weeks after first	Feb., 1916	Living
7.	Male	37	Sarcoma lip	Post-operative		Living
8.	Female	34	Breast cancer	Post-operative	April, 1916	Died June, 1917, metastasis
9.	Female	62	Breast cancer	Post-operative	May, 1916	Living
10.	Female	50	Sarcoma of sternum	Several years duration	July, 1916	Relieved, then recurrence; died
11.	Male	72	Cancer of mouth	3 months duration	Sept., 1916	Died
12.	Male	79	Cancer of axilla	Followed operation	Oct., 1916	Died year later from recurrence in spleen
13.	Male	54	Cancer of tongue	Several years duration	Oct., 1916	Died
14.	Male	76	Cancer of parotid gland	6 months duration	Nov., 1916	Died March, 1917
15.	Female	78	Cancer of breast	Lump in breast; too weak for operation	Nov., 1916	Living and well
16.	Male	57	Hodgkins disease	Several operations, then recurrence	Nov., 1916	Died 1919
17.	Female	58	Cancer of breast	Post-operative	Nov., 1916	Died of a fall resulting in metastasis, 1917
18.	Female	46	Breast cancer	Post-operative	Nov., 1916	Died
19.	Female	42	Cancer of mouth	Post-operative several months before ray was used		Living and well
20.	Male	65	Cancer intestines	Post-operative	Nov., 1916	Died February, 1917
21.	Male	80	Cancer, neck	Post-operative: 2 yrs. later x-ray	Nov., 1916	Recurrent; died Feb., 1918
22.	Female	36	Cancer of axilla	2 years duration	Jan., 1917	Recurrent; died
23.	Female	67	Epithelioma forehead	Post-operative	Feb., 1917	Living
24.	Female	40	Cancer of breasts and neck	Post-operative, paste used, then recurrence, then rayed	Feb., 1917	Living and well
25.	Female	42	Cancer of breast	Post-operative	Feb., 1917	Well and living
26.	Male	40	Cancer of lip	X-ray only	Aug., 1916	Living and well
27.	Male	75	Cancer of face	Year duration	Mar., 1917	Died
28.	Female	75	Cancer of eyelid	Years duration	Feb., 1917	Living and well
29.	Male	67	Leukoplakio	Years duration	Mar., 1917	No report
30.	Male	62	Cancer	Metastic	Mar., 1917	Died
31.	Male	17	Cancer in ethmoid cells	2 weeks duration, metastic	Mar., 1917	Died in 3 weeks
32.	Female	60	Epithelioma of cheek	Several years duration	April, 1917	Living
33.	Female	37	Cancer of breast	Post-operative	Nov., 1915	Living
34.	Female	52	Cancer of breast	Recurrence, post-operation, then x-ray	May, 1917	Living
35.	Male	77	Cancer of nose	Several years duration	May, 1917	Living
36.	Female	47	Cancer of breast	Post-operative	June, 1917	Living
37.	Female	13	Sarcoma of sternum	2 months duration, then x-rayed	July, 1917	Living
38.	Female	55	Cancer of breast	Post-operative	Aug., 1917	Died December, 1917
39.	Female	49	Cancer of breast	Post-operative	Aug., 1917	Living
40.	Female	60	Cancer of breast	Post-operative	Aug., 1917	Died August, 1918
41.	Male	44	Cancer of neck	Post-operative, 2 yrs. interval before recurrence, then x-ray	Sept., 1917	No report
42.	Female	58	Cancer of breast	Post-operative	Oct., 1917	Died May, 1918
43.	Female	39	Cancer of breast	Both breasts removed	Nov., 1917	Living
44.	Female	70	Cancer of nose	Several years duration	Oct., 1917	Living
45.	Female	46	Cancer of upper gum	Several years duration	Oct., 1917	Living
46.	Female	32	Cancer of breast	Post-operative	Oct., 1917	Living
47.	Female	40	Cancer of both breasts	Post-operative	Dec., 1917	Living

NO.	SEX	AGE	DISEASE	HISTORY	DATE OF TREATMENT	RESULTS
48.	Male	45	Cancer of lip	Post-operative	Dec., 1917	Living
49.	Female	69	Epithelioma of face	X ray only	Dec., 1917	Living
84.	Female	50	Cancer of breast	Post-operative	Dec., 1917	Living
51.	Female	63	Epithelioma	X-ray only	Jan., 1918	Living
52.	Male	48	Epithelioma of face	X-ray only	Jan., 1918	Living
53.	Female	50	Cancer of breast	Recurrence	Jan., 1918	Living
54.	Female	43	Cancer of stomach	Post-operative	Jan., 1918	Dead
55.	Male	26	Cancer of stomach	Post-operative	Feb., 1918	Dead
56.	Male	41	Cancer of eyelid	X-ray only	Mar., 1918	Living
57.	Male	48	Sarcoma of thigh	Post-operative	Mar., 1918	Died of pneumonia
58.	Male	48	Sarcoma of axilla	Post-operative, recurrence	Mar., 1918	No report
59.	Female	50	Cancer of breast	Post-operative	Mar., 1918	Living
60.	Female	50	Cancer of breast	Post-operative, recurrence	Mar., 1918	Living
61.	Female	56	Cancer of breast	Operated, recurrence	April, 1918	Living
62.	Male	43	Epithelioma of nose	Several years	April, 1918	Living
63.	Female	66	Epithelioma of nose	Several years	Mar., 1918	Living
64.	Female	30	Epithelioma of nose	Several years	May, 1918	Living
65.	Female	37	Cancer of nose	Several years	June, 1918	Living
66.	Female	43	Cancer of breast	Post-operative	June, 1918	Living
67.	Female	52	Suspected cancer of breast	X-ray only	June, 1918	Living
68.	Female	66	Cancer of breast	Post-operative	June, 1918	Died April, 1919
69.	Male	32	Sarcoma of sternum	2 months duration	Aug., 1918	Living
70.	Female	54	Cancer of thyroid	Post-operative	Aug., 1918	Died
71.	Female	54	Sarcoma of leg	Recurrence	Sept., 1918	No report
72.	Male		Lymphatic sarcoma of neck	Post-operative	Sept., 1918	Living
73.	Female	47	Cancer of breast	Post-operative	Oct., 1918	Living
84.	Female	50	Cancer of breast of breast	X-ray only	Dec., 1918	Living
75.	Male	70	Cancer of neck	Post-operative	Jan., 1919	Died April, 1919
76.	Male	36	Lymphatic sarcoma of neck	1 month's duration, x-ray only	Dec., 1918	Died May, 1919
77.	Male	73	Cancer of lip and neck	Recurrence	Feb., 1919	Dead
87.	Male	43	Epithelioma of face	X-ray only	Mar., 1919	Living
79.	Female	32	Cancer of uterus	X-ray following radium	April, 1919	Died
80.	Male	62	Cancer of neck	Recurrence	May, 1919	No report
81.	Female	30	Cancer of stomach	Several years duration	May, 1919	Died
82.	Male	42	Cancer of stomach	3 months duration	May, 1919	Died
83.	Male		Cancer of neck	Post-operative	June, 1919	Living
84.	Femael	50	Cancer of breast	Operated, recurrence	July, 1919	No report
85.	Female	61	Cancer of breast	Post-operative	July, 1919	Living
86.	Female	77	Cancer of axilla	Post-operative	Sept., 1919	Died
87.	Male	43	Epitheolma of face	X-ray only	Jan., 1919	Living
88.	Male	29	Adenoma both sides of neck	X-ray only	Nov., 1919	Living
89.	Male	65	Epithelioma of face	X-ray only	Nov., 1919	Living
90.	Male	24	Sarcoma	X-ray only	Nov., 1919	Living
91.	Male	63	Cancer of jaw	recurrence	Nov., 1919	Living

PHYSICAL FACTORS UNDERLYING THE USE OF RADIUM AND RADIUM EMANATION

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Chicago

II. The Use of Radium Emanation

In a previous paper the course of the disintegration of radium was discussed both with reference to the rays emitted, and to the complex series of radioactive elements which result. It was pointed out that the alpha rays, while they are the most powerful, are practically useless because of their extremely low penetration, and that for therapeutic purposes only the gamma rays are useful. Hence it is obvious that the radium itself is of no therapeutic use, except as it furnishes Radium B and C, for the gamma rays come only from these two elements. Since the only function of the radium is to produce Radium B and Radium C, it would be advantageous to keep the costly radium in a secure place and to extract from it these active elements.

This can readily be done by employing the physical properties of the radium emanation. As has been stated, this is a gas analagous in every way to the gases of the zero group of the periodic system, such as neon and argon. Because of this fact it can easily be separated from radium. Solid radium salts lose their emanation constantly and slowly, but not completely. In order to drive the emanation entirely from a radium salt, the latter must be heated to a high temperature. When, however, a radium salt is dissolved in water, the emanation collects in the water and above it, and it may readily be pumped out and sealed into containers for use.

During the conversion of radium into the emanation only alpha rays are emitted. The gamma rays are thus still to

come in subsequent changes, and if the emanation is sealed into small tubes it will there disintegrate to give Radium A, B, and C, and the tube will thus rapidly become a source of gamma rays.

The Extraction Apparatus

The apparatus in which the pure radium emanation is extracted is shown in Figure 1. This was originally designed by Dr. William Duane of the Harvard University Cancer Commission, and with several modifications is now in wide use. A is a glass flask containing the radium salt dissolved in weak hydrochloric acid. Because of its value this flask may well be kept in a safe, and of course should be set within another glass vessel as a precaution in case of accidental breakage. From this flask a glass tube leads to the rest of the apparatus through a long vertical glass tube which should be more than 760 mm. in length, in order that the flask A may be completely evacuated without causing the mercury from the bulb C to reach as high as the trap at B. DC and HG are pumps. At N the glass capillary tube into which the emanation is to be sealed, is connected by a direct seal to the glass. A powerful suction pump is connected at M, the mercury in K being lowered by applying a slight suction to the bulb L. The entire system is thus evacuated from M, with the stopcock I open and the mercury in G so low that there is open connection with the purifying chamber at F.

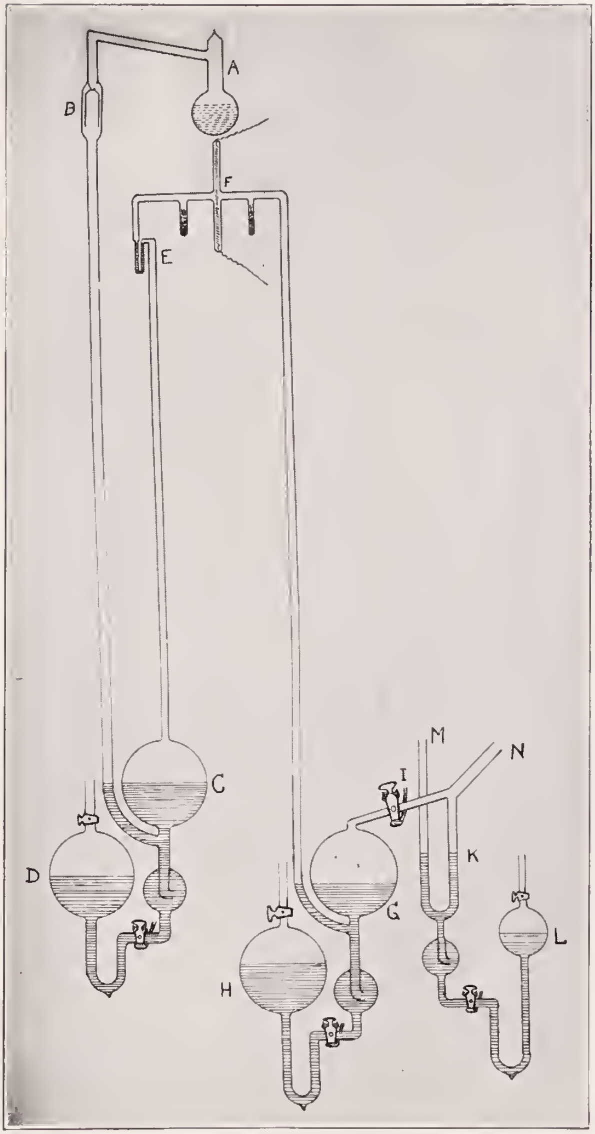

FIG. I

To collect the emanation the apparatus is allowed to stand any desired length of time with the mercury in C raised as shown in the diagram to close the flask A from the rest of the apparatus. For the extraction the rest of the apparatus, including the space above the mercury in bulb C, is evacuated through M, as stated above. The mercury in G is then raised to close off the purifying system F, and the mercury in C is lowered to open communication with the flask A. Because of the much larger volume of the bulb C as compared with A, the greater portion of the emanation diffuses at once into C. Mercury is then allowed to reenter C, thus forcing the emanation through the trap E into the purifying system at F. While it is there being purified the mercury is again drawn down in C, the trap E serving to seal off and confine the emanation in F. When C is again in communication with A, the major portion of the remaining emanation diffuses into C, and this may then be forced into F along with the first portion. A third similar pumping by the bulb C will serve to collect practically all the emanation that has collected in A during the interval allowed.

The emanation needs to be purified because the disintegration of the radium decomposes the water in which it is dissolved. About 15 cubic cm. of mixed hydrogen and oxygen are produced per day by a gram of radium. Since the hydrogen and oxygen are evolved in equivalent quantities, they can readily be removed by causing them to combine with each other. This is accomplished catalytically by means of a thin platinum or a slightly oxidized copper wire wound on a quartz rod and heated electrically by sealing the wire through the glass of the tube F and connecting it with any lighting circuit. The recombination is rapid and complete. The water thus produced is then rapidly removed by phosphorus pentoxide in the two small side tubes. The elimination of water is essential because it would otherwise later be again decomposed by the alpha rays from the emanation and might generate high pressures in the emanation tubes.

After a very few minutes the impurities in the emanation are absorbed and the latter may then be pumped by raising and lowering the mercury in G, and is sealed in the capillary tube connected at N. While the gases as they are pumped from the radium solution have a volume of 15 cc. per day for a gram of radium, the volume of the purified emanation is very much less. A gram of radium produced in a day about 0.1 cubic millimeter or 0.0001 ccm. of the emanation. This minute volume will possess all the gamma ray activity of the radium salt, but can be condensed into very small, almost hair-like capillary tubes of only a few centimeters' length.

The Quantity of Emanation Produced

It was stated in the previous paper that of every 100 billion radium atoms one explodes per second, and that of every 500,000 emanation atoms one explodes per second. Hence when the original 100 billion radium atoms have produced 500,000 emanation atoms, the latter are exploding as fast as they are formed—one per second—and this quantity of radium can never accumulate a greater quantity of emanation. These 500,000 will of course not be the first 500,000 since these will constantly have been disintegrating. At first the accumulation of emanation will be relatively rapid, since the few then present will be slow in disintegrating. But as the figure of 500,000 is approached the speeds of formation and of disintegration become more and more equal, so that near the end of the period the effective accumulation of the emanation is very slow. About one-sixth of the final "equilibrium" quantity is accumulated in the first day, and about one-half by the fourth day. At the end of a month the equilibrium is complete.

The quantity of emanation thus accumulated by one gram of radium at equilibrium is known as one curie, and occupies a volume of 0.0006 ccm. Similarly, a milligram accumulates during a month one millicurie. Thus also, each

milligram produces 0.16 millicurie during the first day and 0.5 millicurie during the first four days after the emanation has been removed. A quantity of 100 milligrams of radium therefore produces 16 millicuries in one day, about 50 in four days, and 100 in thirty days.

According to this law of accumulation it is advantageous to pump off the emanation as often as once a day. For example, if 100 milligrams of radium are at hand, 16 millicuries may be removed after one day's accumulation. After another day 16 more will be available, but the first will have decayed to a value of about 13. Thus the two together have a value of 29. This total value must be the same as the quantity which would have been obtained from the solution at the end of the second day with no extraction on the first day. The advantage of daily pumping, however, is that, while the total quantity is the same, one whole day's use was obtained from the 16 millicuries pumped the first day.

Tabulating thus the quantities furnished by 100 milligrams in solution throughout a week, the advantage of this method is obvious.

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.	SUN.	MON.
Value each day	16	13	11	9	8	6.5	5.5	4.5	4
in millicuries		16	13	11	9	8	6.5	5.5	4.5
			16	13	9	8	8	6.5	5.5
				16	13	11	9	8	6.5
					16	13	11	9	8
						16	13	11	9
							16	13	11
								16	13
									16
Total to date	16	29	40	49	57	63.5	69	73.5	77.5

The total quantities represented by the combined activities of all tubes on hand on any day represent the amount of emanation which could have been extracted on that day if none had been taken from the radium in the interval. Thus after a day about one-sixth is available; after four days, one-half; after a week, about three-fourths; after two

weeks, about 90 per cent, and after a month practically the entire equilibrium quantity of 100 millicuries. The figures are only approximate, and do not allow for the inevitable loss of about five per cent in the process of extraction.

After a week each tube has decreased to about one-fourth of its original activity, and in the cases cited is too weak to be of much therapeutic value. Several such tubes are then conveniently mounted together in a frame or on a strip of tape to give an applicator of their combined value but distributed over a greater area. Or they can, with proper apparatus, be opened and their combined contents can be introduced again into a single tube with practically no loss. In the continuous use of the emanation extraction apparatus with daily removal of the gas 92 to 96 millicuries would at all times be available, distributed in tubes of various strengths as indicated. In the case of larger quantities of radium the quantities of emanation would of course be proportionately increased.

In order to follow the extraction work accurately and to insure proper dosage in treatments, it is extremely desirable to have at hand one of the various types of measuring instruments. Instruments have been devised which will show on a scale reading directly in millicuries the value of each tube by simply placing it in a receiver at the proper position of the instrument. Such instruments can be conveniently used by nurses and others not skilled in radioactive measurements.

Convenience and Applications of the Emanation Tubes

The chief argument for the use of the emanation rather than the radium itself is the insurance against loss of the radium. The latter is kept securely locked in a safe and is at no time in serious danger of loss. In practice it frequently occurs that radium tubes are removed with bandages or work their way loose or are misplaced. If this happens in the case of an emanation tube there is no real loss, since the tubes have no intrinsic value and would decay to worthlessness in a few days in any case. Thus the entire gamma

ray activity of the radium is at all times available with no risk whatever.

There are, however, other arguments in favor of the use of the emanation. It can be concentrated into extremely small volume. Sixteen millicuries of emanation can be put into a tube with a total diameter of one-half of a millimeter and a length of five millimeters, which is far less than the size of a capsule containing sixteen milligrams, the corresponding quantity, of radium salt. This is often a critical factor in their application. An emanation tube can, for instance, easily be introduced into a trocar and inserted into body cavities by puncturing or otherwise, where a similar procedure in case of the large radium tube would be out of the question. Greater flexibility is also possible since the tubes can be made of any size or shape and furthermore can be arranged in applicators of any desired strength by combining tubes of various strengths either in one tube or by distributing them over any desired area.

There are several precautions which have not yet been mentioned. One is that the gamma rays do not come from the emanation itself but from the products of its disintegration; *i. e.,* from Radium B and C. Hence when the emanation is first introduced into the glass tubes it is free from these products and gives no beta or gamma rays. These rapidly develop, however, and in the course of three hours Radium A and B have reached their equilibrium quantity so that the tube is at its full gamma ray strength. Another precaution is that the tiny glass tubes are extremely fragile and should be inclosed within steel needles or other protective covering when in use. Such a needle need not exceed a millimeter in diameter and two centimeters in length, even for fifty millicuries of emanation.

Other Applications

The emanation extraction apparatus allows still further variations. In case of surface treatments it may become

desirable to make a direct application of a strongly radioactive preparation which makes use of the alpha and beta rays. For this purpose sheets of silver or of copper may be inclosed in a glass vessel, sealed at N in Figure 1, and allowed to stand in contact with the emanation for several hours. It will thus take up a deposit of Radium A, B, and C. When then removed it serves as an extremely active source of radiation while these elements last, which is about three hours. Very fine needles may thus be activated for work in confined areas.

Furthermore, radioactive preparations for intravenous or other injections may be prepared by similarly exposing sodium chloride to the emanation and allowing it to take up these active elements. The solution of the salt for injection is then temporarily strongly radioactive. Such solutions are not subject to the objections that apply to the injection of radium itself, for the question of their elimination by the system is not involved. In the course of three hours their activity dies out almost completely, and if longer treatments are desired the injection must be repeated.

Finally, in the case of massive tumors it is occasionally desirable to give a prolonged treatment. This can be done by inserting or burying the emanation tube within the mass of the tumor and allowing it to remain until its activity is lost or until the tumor is removed.

University of Chicago

The Portland Roentgen Club, of Portland, Oregon, was organized and held their first meeting January 14, 1920, in the office of Dr. Jos. Sternberg, Journal Building, at eight o'clock. Dr. Roy N. Payne read a paper, "Abdominal Tuberculosis"; the discussion was by Dr. Dorwin Palmer.

AN INTERESTING CASE OF FOREIGN BODY

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The following case illustrates the value of the *x*-ray where a foreign body in the tissue is suspected and emphasizes the fact that, where there is the slightest ground for suspicion, the use of the *x*-ray is imperatively indicated.

D——, six years of age, while playing with his toys, fell and injured his knee. He was supposed to have struck the patella against a small metal steamboat. The family physician treated the case for a day or two, and becoming suspicious of the presence of a foreign body, advised the parents to seek surgical counsel. Upon examination I found linear incised wound about ¼ inch in length at about the middle of the right patella, parallel with the axis of the limb. There was slight infection and moderate swelling. Palpation was negative, a probe revealed the presence of a foreign body. The *x*-ray showed the foreign body beautifully, as evidenced by plates 1, 2. On removal the body proved to be a painted circular piece of tin which was part of the little steamboat on which the child was supposed to have fallen. Fig. 3. The knee joint was uninjured and healing was prompt and satisfactory, with no subsequent disturbance of function of the knee.

Plate 1

Plate 2

PLATE 3

25 E. WASHINGTON ST.

THE JOURNAL OF RADIOLOGY

PUBLISHED EVERY MONTH AT IOWA CITY, IOWA

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Subscription prices, per annum in advance, including postage: Domestic, $5.00; Foreign, $6.50.

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The

JOURNAL *of* RADIOLOGY

Published by the Radiological Society of North America

VOLUME I May, 1920 NUMBER 5

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X-RAY CHARACTERISTICS OF LUNG SYPHILIS*

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In a preliminary report,[1] three years ago, the statements were advanced that lung syphilis is more frequent than is commonly admitted by clinicians, and that it presents certain radiographic characteristics which are peculiar, materially assisting in differentiating this infection from other lung lesions. Neither of these statements pretended to be original. The first was abundantly supported by clinical authorities, although reports had been frequent from investigators like Clayton[2] who found no instance of lung syphilis among 13,000 specimens in the Army Medical Museum, or Ford[3] who found none among the thousands of autopsies at Massachusetts General Hospital, or Backok[4] who found only two cases in 6000 autopsies in Chicago. Osler,[5] after reporting no pulmonary syphilis among 2500 autopsies at Johns Hopkins, later found twelve cases in 280 autopsies; Peterson[6] found eleven cases of lung syphilis in 88 syphilitic subjects; and Dieulofoy[7] is responsible for the statement that the frequency of this diagnosis is in proportion to the ability of the clinician or pathologist to recognize the condition. Our second statement was supported by such roentgenologists as Bauch,[8] Callender,[9] Dachtler,[10] Holmes,[11] Moore and Carman,[12] Burnham,[13] Post,[14] Ronssel[15] and Manges.[16]

During the last three years, several important communications have appeared, either featuring lung syphilis, or giving the condition due mention. Barker,[17] in a general review, gives prominence to lung syphilis. Morris,[18] in two articles, describes the pathological changes, symptoms and

*Read before the Radiological Society, New Orleans, April 23, 1920.

diagnosis, but omits any reference to the roentgen ray. Warthin,[19] in his Harvey lecture on the new pathology of syphilis, calls attention to the probability of the frequent occurrence of lung lesions and to the necessity of studying their pathologic anatomy in the light of the newer ideas of syphilitic infection. Hubeny,[20] a roentgenologist, states that lung syphilis is now recognized as occurring more frequently than was formerly supposed, but that our knowledge of the disease and ability to diagnose it leave much to be desired. Funk,[21] in a recent article, discusses lung syphilis in its simulation of tuberculosis, quoting the roentgenographic reports of Manges on his cases; he regards the x-ray as a very valuable aid, to be used in every case where lues is suspected. Lisser,[22] in a very comprehensive article, divides the recorded work on lung syphilis into three periods. The first period ended in 1800 with Laennec's differentiation of pulmonary tuberculosis as a distinct entity, thereby opening the way for a study of other lung diseases, including lung syphilis. The second period began with Depaul's work in 1838 and included the classical pathological descriptions of lung syphilis by Virchow[23] and Pancritius,[24] to which nothing of distinct value was added until very recently. This period also includes numerous clinical reports, varying widely in opinion as to the frequency of the disease and its clinical forms; among these, the classifications of Stanley[25] and Fowler,[26] in the latter part of this period, deserve particular mention. The third period began with the discovery of the spirochete as the causative agent, covers the period of popularizing of laboratory methods of diagnosis, the discovery of salvarsan, and the dawn of the idea that lung syphilis is a very common infection. We are now entering the fourth period in the study of lung syphilis, which is to be the roentgenological period. It began with the revelations of Fordyce[27] and Warthin[19] regarding the essential pathology of the disease, and the application of these new principles to the lung lesions by Carrera.[28] This new work in the pathologic anatomy of lung syphilis must

inevitably result in the widespread application of roentgenography in differentiating lung syphilis from other lung lesions.

Roentgenologists have, of necessity, made very halting progress in applying their science to this disease. Scientific roentgenography must be founded upon a known and established pathology, and our knowledge of the real pathology of lung syphilis was, until very recently, very vague and fragmentary. The lack of such information was keenly felt when we undertook to report a few cases in 1917. In the absence of a definite pathology, our conception of what ought to be the *x*-ray shadow of lung syphilis was based on a tripod of facts: (1) an almost universal agreement among clinicians that the usual location of lung syphilis is in the base or central portion of the lung; (2) the characteristic method of invasion of syphilis wherever it occurs and the characteristic lesion, as described by Fordyce and Warthin; (3) the anatomical peculiarities of the lung structure, particularly the relations of bronchi, lobules, and blood vessels, as described by Miller.[29] This, however, was an imperfect approach to scientific accuracy. A definite knowledge of the gross and microscopic peculiarities of lung syphilis, in harmony with the discoveries of the last few years, was essential. This has recently been supplied by Carrera, working under the direction of Prof. Warthin, at the University of Michigan. From an exhaustive study of the lungs of 152 autopsy cases of syphilis, he has given a detailed pathological description of the lesions found, and a classification of the types of lung syphilis to be expected. He makes scant mention of the value of *x*-ray in visualizing this pathology during life, concluding his paper with the statement that the diagnosis of pulmonary syphilis must be made microscopically. This is not a happy outlook for the patient, but roentgenologists dare challenge this conclusion. If there occur, in the lungs, lesions which are characteristic of syphilis and which can be differentiated grossly and microscopically from other lung diseases, these lesions will

produce characteristic x-ray shadows which can be distinguished from the shadows of such other lung diseases. We cannot, as yet, make the absolute diagnosis demanded by the ultrascientific pathologist, since this requires the death of the patient and the inspection of his lesions under the microscope, but we can satisfy the in vita expectations of the clinician. We do not ask that our unsupported word be accepted that certain shadows on the radiograph are caused by syphilis of the lung; we ask that the same criteria be applied which are unhesitatingly used regarding ulcers of the skin, periostitis, iritis, condylomata, etc., which are accepted as syphilitic when they accompany a positive Wassermann and disappear under antiluetic treatment. The x-ray represents simply an artificial extension of vision to internal structures and tissues, and its revelations ought to be just as acceptable as are the circumscribed and frequently distorted images presented by the cystoscope, proctoscope or bronchoscope. If we find, in a patient clinically or serologically syphilitic, pulmonary shadows which are in accord with the accepted pathology of syphilis, and if these shadows disappear under specific treatment along with the local symptoms, the demonstration is just as conclusive as the same procedure would be, if the lesions were in the skin, bone or glands.

Our method of studying the radiographic shadows of lung syphilis has been similar to that followed by necropsy workers, and represents three distinct steps:

(1) We have selected cases known to have syphilitic lesions of the heart and aorta, as shown by aneurism or aortitis with positive Wassermann reactions. If we found in these chest shadows which could be differentiated from tuberculosis and other common lung lesions, we felt entitled to make a provisional diagnosis of lung syphilis. If now, these pulmonary lesions disappeared under antileutic treatment, we had as definite a demonstration of their syphilitic nature as we could possibly secure while the patient lived and escaped the microtome knife.

(2) Having thus fixed in our minds the radiographic characteristics of lung syphilis as found accompanying demonstrable syphilis of the circulatory system, we studied the shadows in the lungs of patients who were known to be syphilitic but without visible heart or aortic involvement. By demonstrating that the shadows in the lungs of these patients, similar in all respects to those found in conjunction with cardiac syphilis, disappeared under antiluetic treatment, we felt justified in recording these shadows as demonstrably syphilitic in origin.

(3) We now passed over onto debatable ground, where we now stand ready to battle for our faith, and considered the pulmonary shadows found in patients without positive Wassermann reactions. There will always arise critics to question the cause of such shadows, but many of them were accompanied by very definite confirmatory evidence, such as, (a) the occurrence of characteristic pulmonary shadows in patients with syphilitic history but negative Wassermann, (b) the occurrence of shadows in conjunction with aortic dilatation of a character usually regarded as syphilitic, but with the Wassermann negative; (c) the disappearance of pulmonary shadows under antiluetic treatment while the Wassermann remained negative. A critical study of these factors in conjunction with suspicious lung shadows has been made and now, on the basis of certain roentgenographic characteristics alone, we frequently give syphilis the position of preference among the diagnostic possibilities, even when the Wassermann is negative. This is a sufficiently close approach to a roentgen diagnosis in the present stage of our knowledge of the pathologic anatomy of pulmonary lues.

Out of approximately five thousand *x*-ray examinations of the heart and lungs made in our laboratory up to March 1, 1920, there were 250 which showed cardiac involvement suggesting syphilis. Fifty-nine of these either had a definite history of syphilis or gave positive Wassermann reactions at the time of our examination. Among these, there

were twenty-nine who presented shadows of lung disease which were diagnosed lung syphilis, either at the time or in subsequent critical studies of the radiographs. There were twenty-two patients showing dilatation of the aorta but who gave negative Wassermann reactions and eight such patients on whom Wassermann was not performed. Among these thirty patients, there were twenty-three with shadows of lung disease similar in all respects to those found in the group showing cardiac syphilis.

Among the five thousand, we have record of 214 patients without demonstrable aortic or heart disease, regarding whom the question of lung syphilis was raised on account of the clinical signs or serological findings, or both. Fifty-two of these had chest symptoms and gave positive Wassermann reactions, but showed no definite or characteristic pulmonary shadows. Sixty-eight of the patients showed symptoms which were diagnosed as combined tuberculosis and syphilis, sixty giving positive, and eight negative, Wassermann reactions. Ninety-four presented shadows which were diagnosed as *probable* lung syphilis, sixty of these having positive Wassermann reactions, twenty-five negative, and no reactions performed on nine.

We have, therefore, in eighty-nine patients made diagnosis from the *x*-ray shadows and associated evidence, of lung syphilis, in the presence of known syphilis. We have, in fifty-seven additional cases, made a probable diagnosis of lung syphilis, where the Wassermann was negative, our chief evidence being the roentgen characteristics of the pulmonary shadow. These 146 cases would represent an incidence of lung syphilis in nearly three per cent of patients examined for heart and lung disease, in a series of five thousand cases. This does not include the sixty-eight patients in whom a symbiosis of tuberculosis and syphilis was diagnosed. We might say, in passing, that this double infection occurs much more frequently than this figure would indicate, our later observations tending to show that this sinister combination occurs in from ten to fifteen per cent of tuberculous patients.

Following the publication of Carrera's researches, we reviewed our work and attempted to classify the 146 cases diagnosed as lung syphilis, as nearly as possible in accord with the types of pathology found by him. This could not be done absolutely, since his classification is mainly histological and the radiographic lesions are more nearly in accord with the clinical divisions of Stanley and Fowler.

Gumma:—We found shadows which we diagnosed gummas in ten patients, always in combination with other types of pathology. Carrera's description of the pathological picture of the gumma is interesting, since it so accurately foretells what the radiographic picture will be:—

"The caseous gummas showed three distinct zones, a central caseous area, an intermediate fibrous zone with many new blood vessels and an outer, vascular infiltrated zone rich in plasma cells and lymphocytes. In some of the gummas, the outer zone is very broad and diffuse, disappearing gradually in the thickened walls of the bordering alveoli, while others have a more discrete border, but never as sharply circumscribed as the edge of a tubercle. . . . Gummas do not become confluent as do miliary tubercles. A striking difference from tuberculosis is shown by a gradual transition of the lesion to the neighboring tissues. The scars of the healed gummas are very characteristic. They are never round, but have an irregular form with extensive ramifications and are very vascularized."

The roentgen ray shadows of such lesions, then, will vary in size, will usually be multiple, discrete, will have irregular mossy edges, gradually fading into the surrounding clear lung areas; they will have centers of diminished density when caseous; when healing, they will become irregular in outline, will show pointed projections of fibrous tissue and the stellate scars will contract the lung.

Peribronchial Fibrosis,—the peribronchitis of Carrera, the early diffuse sclerosis of Stanley and the chronic interstitial pulmonitis of Fowler:—This type of lesion occurred in 39 patients of this series, as the predominant change. It presents marked and diffuse linear radiations from the hilum, either into all portions of the lung, or into certain por-

tions only. Carrera says that "fibrosis is the termination, the sequel, of the inflammatory process, and only the active area of inflammation will present specific characteristics by which we can diagnose it positively." Such peribronchial fibrous shadows will generally be found radiating in all directions from the hilum, will be more diffusely distributed than tuberculous fibrosis and will not show calcification. We are justified in classifying such diffusely radiating shadows of peribronchial fibrosis as syphilitic, if we can find accompanying stellate densities of healed gummas, or syphilitic bronchopneumonic patches, and if these shadows can be seen to change and the symptoms improve under specific treatment. The differentiation of such shadows from the brown induration of passive congestion is, as Carrera states, difficult, both from a pathologic and a roentgenologic standpoint.

Syphilitic Inflammatory Infiltration (Bronchopneumonia of Fowler and Syphilitic Consolidation of Stanley):—This is the most frequent and important type of lung syphilis, since it is the most amenable to treatment. It occurred fifty-eight times in the series as the predominant lesion and always in more or less evidence, whatever the type. The shadows of syphilitic infiltration differ from the ordinary bronchopneumonia in being more irregular in outline, more confluent, more inclined to mossiness of the edges, more localized in the bases and are accompanied usually by less stormy general symptoms. The shadows resemble those of carcinoma of the lung or pneumoconiosis when located adjacent to the hilum, or may be confused with abscess, bronchiectasis or lobar pneumonia, when located in the bases. The forcing of these diseases into consideration where they can be ruled out by reason of non-conformity to the general picture, narrows the diagnostic possibilities very decidedly, and permits the differential diagnosis to be completed by consideration of the history, general symptoms and laboratory findings.

Dense Fibrosis of the lungs and pleura (Dense Sclerosis

of Stanley and Syphilitic Phthisis of Fowler):—This was found in five patients. It is shown on the radiograph by total density of one lung, throughout all or a portion of its extent, with contraction of the lung and retraction of the heart and mediastinum. The dense sclerosis is an end result and, when complete, does not differ in its *x*-ray peculiarities from similar end results from other causes. We acknowledge the correction of Funk, in this connection, as applied to our previous paper, where one of our cases was placed in this class when it should have been classed as an inflammatory infiltration.

Indefinite Lung Densities:—These correspond to the passive congestion, pulmonary edema or brown induration of Carrera. On the radiograph, they resemble nothing so much as the waterlogged and edematous lung of influenza. They are practically always found accompanying cardiac syphilis or aneurism and probably are secondary effects. We found such shadows, without other evidence of pulmonary involvement in thirty-four cases of the series.

Conclusions

Pulmonary syphilis has become a recognized clinical and pathological entity and is amenable to radiographic diagnosis.

Until there is further advance in a knowledge of the pathologic anatomy of this condition, the *x*-ray evidence must be substantiated by clinical signs and by the result of treatment.

The *x*-ray classification of shadows closely follows the most recent advances in pathologic knowledge of lung syphilis.

Out of five thousand examinations of the heart and lungs, one hundred and forty-six cases were diagnosed,—positively or probably,—as uncomplicated lung syphilis and sixty-eight cases as combined tuberculosis and syphilis, the latter figure being far below the actual incidence of this combination.

The fourth period in the development of our knowledge of lung syphilis should be developed jointly by the tissue pathologist and the roentgenologist mutually assisting each other.

BIBLIOGRAPHY

1. Watkins,—Amer. Jour. Syph., Oct., 1917.
2. Clayton,—Am. J. Med. Sc., 1905, cxix, 565.
3. Ford,—Urol. & Cut. Rev., 1914, xviii, 536.
4. Backok,—Quoted by Carrera.
5. Osler,—System of Syphilis, London, 1909; Modern Medicine, 1913.
6. Petersen,—Quoted by Carrera.
7. Dieulofoy,—Textbook of Medicine.
8. Bauch,—Med. Record, May 20, 1916.
9. Callender,—Inter. Med. Jour., June, 1915.
10. Dachtler,—Quoted.
11. Holmes,—A. J. Roent., July, 1918.
12. Moore & Carman,—Am. J. Roent., March, 1916.
13. Bost. M. & S. Jour., Sept. 10, 1914.
14. Post,—Bost. M. & S. Jour., 1916, clxxiv, 876.
15. Roussel, N. Y. Med. Jour., Sept. 17, 1913.
16. Manges,—Quoted by Funk.
17. Barker,—Am. J. Syph., Jan., 1917.
18. Morris, Am. J. Syph., April, 1918.
19. Warthin, Am. J. Syph., 1918, ii, p. 1.
20. Hubeny,—Med. & Surg., June, 1917.
21. Funk,—Rev. of Tuberc., Feb., 1920.
22. Lisser,—Am. Jour. Med. Sci., March, 1918.
23. Virchow,—Arch. f. Path. Anat., 1880, lxxxii, 217.
24. Pancritius,—Uber Lungensyphilis, I. D. Berlin, 1881.
25. Stanley,—Brit. Med. Jour., 1911, i, 181.
26. Fowler,—Dis. of Lungs, 1898.
27. Fordyce,—Am. Jour. Med. Sci., June, 1915.
28. Carrera,—Am. J. Syph., Jan., 1920.
29. Miller,—Proc. Robt. Koch Soc., 1916.

THE PERITONEOSCOPE IN DIAGNOSIS OF DISEASES OF THE ABDOMEN*

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In this paper, I will endeavor to describe briefly an instrument which I wish to designate the *peritoneoscope,* give the technique we have employed in its use and also to discuss briefly its clinical application.

Peritoneoscope

My first work in peritoneoscopy was conducted on animals, using a pharyngoscope with lamp and lens system. Cystoscopes were used also. Later my attention was directed to a thoracoscope devised by H. C. Jacobanes of Stockholm by Mr. G. W. Wallerich of V. Mueller & Company. Certain modifications of this instrument have facilitated the work of peritoneoscopy greatly.

The instrument consists of four principal parts as follows:

Trocar

The trocar is the ordinary type ground with three faces with sharp point and margins and sized to fit the cannulae in length and diameter.

Cannula

The cannula consists of a tube 15 French in diameter, which permits the trocar or the lamp and lens system of size

*Read in part before the Loyola Research Society, Chicago, January 14, 1920; American Congress on Internal Medicine, Chicago, February 25, 1920; Omaha Roentgen Society, March 27, 1920.

13 French to be inserted through it. At the approximal end of the cannula the automatic valve is attached. The valve is so constructed as to permit the trocar or lamp and lens system to pass and at the same time prevent the escape of gas from the peritoneal cavity. It is desirable to have cannulae of different lengths because of the great variation in thickness of the abdominal wall in different individuals. We have used two lengths—5 and 15 centimeters respectively.

Tube and Hose Connection

This part is provided with a small tube 13 French in size with a hose connection at one end and is used to insert through the cannula for the purpose of introducing gas into the peritoneum or removing it.

Lamp and Lens System

This part comprises a barrel 13 French in size and supports a lens system within. At the distal end a small cold filament electric lamp is supplied, which is illuminated after the manner of an ordinary cystoscope and controlled by a small rheostat and transformer or a storage battery. Just proximal to the lamp there is provided a small window through which the illuminated image is conducted through the lens to the operator. The operation of the instrument when inserted is very similar to that of the cystoscope.

Technique of Introducing the Peritoneoscope

The technique consists of: (1) Selecting the site. (2) Preparing the field. (3) Administering the local anaesthesia. (4) Producing a pneumoperitoneum. (5) Conducting such *x*-ray observations as seem necessary. (6) Inserting the trocar and cannula of the peritoneoscope. (7) Adjusting the amount of gas in the peritoneum to give the proper distension. (8) Inserting the lamp and lens system and making observations together with the aid of the *x*-ray and fluoroescent screen. (9) Varying the position of the

patient to facilitate the observations in the screen and peritoneoscope. Finally, withdrawal of the gas from the peritoneum and closing of the wound at the site of puncture.

(1) In selecting the site, one should endeavor to find an area in the region of the umbilicus free from induration or other evidence of pathology in the abdominal wall and under which there seems to be the soft elastic air filled loops of small intestines. A point two or three inches to the right or left of the umbilicus has been satisfactory as a rule. In certain instances, it seems well to select a site over the area to be examined, but in most instances it seems better to enter the abdomen at a point from which any portion of the peritoneal cavity may be examined.

(2) It has been our custom to prepare the field as follows: A solution of Lysol and Glycerine 50% of each is applied at the site selected by means of a wooden applicator on which has been wound a small bit of cotton. The site is covered with the antiseptic solution and by adding pressure to the applicator a degree of pressure anaesthesia is produced. A rather thick layer of the solution is left covering the site.

(3) The local anaesthesia used in our work has been a 2% solution of Novocaine and Apothesine with Adrenaline. From 5 to 10 cc. is injected through a needle about 20 gauge and at least 5 centimeters in length. The needle is thrust through the layer of antiseptic solution and the skin at a point where the pressure was applied through the applicator. A small amount of the solution is injected endermically. The remaining solution is injected as the needle is passed through the abdominal wall. The resistance offered by the deep fascia and peritoneum is usually recognized and it is at these points where the solution must be effective in order to avoid distress. It is not necessary to insert the needle through the peritoneum.

(4) The intraspinal needle used in connection with the apparatus for producing pneumoperitoneum is inserted through the skin at the same point the anaesthesia needle

entered it. The antiseptic solution is renewed to the site before the needle is inserted. With the pneumoperitoneum apparatus ready and connected with the needle, which is grasped firmly in one hand while the other grasps the abdominal wall and with the needle almost parallel with the surface of the abdomen and with tension on the abdominal wall opposite to the direction of the needle, the latter is forced through the skin. The direction of the course of the anaesthesia needle is now followed by raising the pneumoperitoneum needle to a point at right angles to the surface of the abdomen. The needle is now carefully thrust through the abdominal wall, noting again by the resistance offered the muscle, deep fascia, the rather small intervening space and finally the resistance offered by the peritoneum. As the needle passes the peritoneum a lack of resistance is immediately noted. The oxygen is turned on very slowly; the flow is noted in the water bottle indicator. The pressure in the apparatus is noted on the gauge. When the needle is free in the peritoneal cavity the pressure gauge will not record a constantly rising pressure but a uniformity of pressure indicating free exit of oxygen from the needle.

(5) *X*-ray fluoroescent screen observations are now quite desirable in order to determine the relative distension of the peritoneal cavity. One is also able to locate pathological organs which it would be desirable to avoid when the peritoneoscope is inserted. When the anterior abdominal wall has been lifted from the viscera a few centimeters, the flow of oxygen is stopped and the needle withdrawn.

(6) After covering the site again with the antiseptic solution a narrow bladed scalpel is inserted through the skin and subcutaneous tissues after which the trocar and cannula of the peritoneoscope is inserted. It is well to exercise great caution when entering the peritoneum for in the fluoroescent screen one will observe it to bulge down considerably before it is penetrated by the trocar. As soon as the resistance of the peritoneum is released, the trocar is withdrawn and the cannula can be inserted further into the distended peritoneal cavity.

(7) The tube and hose connection is now inserted into the cannula through the automatic valve and the patient placed in different positions during the observations in the x-ray fluoroescent screen in order to determine when the proper amount of oxygen has been administered in order to secure the most efficient observations where pathology is suspected. The hips are usually elevated for examination of the pelvic organs while the shoulders are elevated when an observation in the epigastrium or gall bladder region is indicated. It may be necessary also to have the patient turn with right or left side upward in order to have the gaseous media surround the organ or area to be examined.

(8) The lamp and lens system is now inserted and guided to the proper field in the peritoneal cavity by the aid of the x-ray screen observations. It is frequently of considerable aid to move the structure under observations in the peritoneoscope by external palpation or rectal or vaginal palpation. The position of the patient must be changed in order that the organs under examination may be brought into a position which permits observations most clearly.

(9) At the conclusion of the peritoneoscopy, the lamp and lens system is withdrawn, the tube and hose connection is inserted into the cannula and the gaseous media is allowed to pass out. The cannula is now removed and after covering the site again with the antiseptic solution a gauze dressing is applied and held over the site by adhesive plaster for several days.

Clinical Application

My experience with the clinical application of this method of diagnosis began in December, 1919, and was first reported before the Loyola Research Society, January 14, 1920, Chicago. The method has been employed in forty-two cases. I will endeavor to call attention to some of the clinical conditions in which findings of value may be derived.

1. *Tubercular Peritonitis.* In this condition there seems

to be two rather well defined classes. The first I refer to as *Localized Tubercular Peritonitis.* In the cases I have examined, the parietal peritoneum presented the usual shiny glazed appearance with the blood vessels appearing through the transparent peritoneum in a normal manner. This appearance was maintained over the portions of the omentum observed and also over certain loops of intestines, especially in the epigastric region. In the region of the pelvis the blood vessels in the peritoneum seemed dilated and there was noted opacity of the peritoneum generally which tended to render the small blood vessels obscure. In certain cases the oviducts on one side varied from the other by being larger, paler in color with the peritoneum more opaque. In two cases, the right oviduct showed the presence of small white spots approximately 1 millimeter in diameter. These spots were slightly elevated above the surface and their appearance suggested strongly their character as tubercles. These tubercles have been observed on the broad ligaments and the peritoneum of adjoining structures. In one case, the oviduct was removed surgically and a section for microscopic examination corroborated the diagnosis of tuberculosis.

2. Second class I refer to as *Generalized Tubercular Peritonitis.* As yet, I have not observed a case in the human. Several cases have been observed in animals appearing to present similar pathological findings to that of the human. The general opacity of the peritoneum with the appearance of the typical tubercles seem to offer very reliable findings in diagnosis.

It is my opinion that when careful observations through the peritoneoscope have been conducted a quite reliable negative diagnosis of Generalized Tubercular Peritonitis may be given.

2. *Hemoperitoneum and Hydroperitoneum.* The appearance of blood in the peritoneal cavity even in minute quantities is easily observed. This is especially true when the general peritoneum has approximately a normal appear-

ance. In several cases examined in the presence of malignancy only very slight bloody tinge of the fluid was observed. It would seem that this method offers reliable findings in cases with suspected hemorrhages into the peritoneum regardless of its source. In post-operative shock with the possibility of slow hemorrhage into the peritoneal cavity, I have been able to introduce the instrument through the incision without interfering with the sutures and with but little distress to the patient.

3. *Extra Uterine Pregnancy.* The findings in this condition must vary greatly. Hemoperitoneum would be at once discernible in the case of a ruptured oviduct with ectopic pregnancy. In the two cases I have examined, large masses of clotted blood were found in the true pelvis which rendered visualization of the genital organs obscure in one case, while in the other, I was able to determine the oviduct as the probable source of the hemorrhage. While my experience is greatly limited in the use of this method, I am convinced that findings may be elicited which will be very helpful in differentiating Extra-Uterine Pregnancy.

4. *Salpingitis.* The appearance of the oviducts varies greatly in accordance with the varions pathological conditions. Two cases of chronic pyosalpinx were white, smooth and avascular in appearance and numerous fibrous adhesions occurred between them and adjoining structures. The uterus was dark red in color and showed much evidence of vascularity. In one subacute pyosalpinx, gonorrheal in origin, the oviducts were enlarged and a deep red in color. The fimbria was swollen and free from adhesions. The peritoneum over adjoining structures showed evidence of inflammatory reaction. Two cases of chronic pyosalpinx were examined where the pelvic organs could not be observed due to adhesions involving the omentum and other structures in that vicinity.

Small cysts attached to the fimbria and broad ligament containing almost clear fluid have been observed in five cases.

5. *Ovarian Cysts and Tumor:* Cysts in one or both ovaries have been observed in twenty-eight of our forty-two cases. The peritoneum over a cyst appears shiny and avascular as a rule and very small cysts may be observed. The peritoneum over very large ovarian cysts has appeared almost normal and without the aid of the x-ray and combined bimanual vaginal palpation one would encounter great difficulty in determining the identity of the structure under observation.

6. The appearance of the peritoneum over tumor masses regardless of their origin may present findings of diagnostic value. Tumors with origin in the pancreas in two cases have presented an injected hyperemic appearance, while metastasis in the spleen and liver have been light in color and anemic in appearance. Three cases of carcinoma of the stomach showed a red injected peritoneum over the involved surface of the pyloric end of the stomach as well as extension along adhesions on the anterior abdominal wall. While metastasis extending over the surface of the liver was anemic in appearance, in one case of lymposarcoma with large tumor masses in the mesentery, were covered with peritoneum almost normal in appearance. One case of lymposarcoma showed hemoperitoneum with a general hyperemic peritoneum both visceral and pariteal with an absence of the shiny glazed appearance. The spleen in myeloid leukemia covering almost the entire anterior surface of the abdomen had a grayish red appearance. After marked improvement following x-ray therapy, the spleen appeared much darker red in color.

The gall bladder varies greatly in different cases. Certain cases are dark with bluish tendency, others gray with vascular injection and may be somewhat pink in color. Adhesions have frequently held the gall bladder obscure from view.

7. *Transillumination of the Abdominal Wall* and other structures may offer findings which would warrant their consideration in diagnosis. The appearance of the umbil-

ical ring where one is able to visualize the diameter of the aperture in the fascia is conspicuous. The gapping of the fascia along the site of a scar following laparotomy can be observed by transillumination. The posterior bladder wall may be transilluminated by inserting a cystoscope in the bladder, filling the bladder with oxygen and observing the light through the bladder wall from the opposite instrument.

Summary

1. Peritoneoscopy may be carried out by this technique without causing much distress to the patient and with proper attention to aseptic and antiseptic measures the danger of inflammatory complications seems very small.

2. The procedure renders it possible to thoroughly visualize the peritoneum, parietal and visceral and pathology in structures beneath the peritoneum may show findings helpful in diagnosis.

3. A training in the use of the cystoscope and a knowledge of the appearance of normal abdominal viscera after pneumoperitoneum has been produced in the *x*-ray fluoroescent screen are very helpful qualifications for beginning peritoneoscopy.

4. This method should in no way displace other methods of diagnosis, but it is intended that it should be used only in conjunction with a careful clinical study of the case.

In reporting this work, the writer wishes to express his most sincere thanks for the helpful coöperation and encouragement received from members of the staff of the Frances Willard Hospital.

25 E. Washington St.

CASE 42. No. 4193

The illustration is a lateral view. Patient lying left side upward.

The illustration shows the cannula of the peritoneoscope at the shadow of the spine just above the crest of the ileum. The purpose of the illustration is to show that this small part of the instrument may be safely left in situ while the patient may be placed in various positions for further x-ray observations or peritoneoscopy.

CASE 18. No. 3623

Illustration is lateral view. Patient lying left side upward with hips elevated. The oxygen is seen to have displaced the organs in the pelvis. The pelvic brim is observed for more than one-third of its circumference. The dense mass beneath the position of the pubis is the uterus. The small dense line radiating upward from the center of the uterine density is the round ligament. The density of the oviduct leaves the uterus near the round ligament and bends upward toward a position in the left side of the pelvis. The ovary lays just to the left and above the shadow of the uterus. Its shadow is continuous with one of equal density which extends to the left lateral wall.

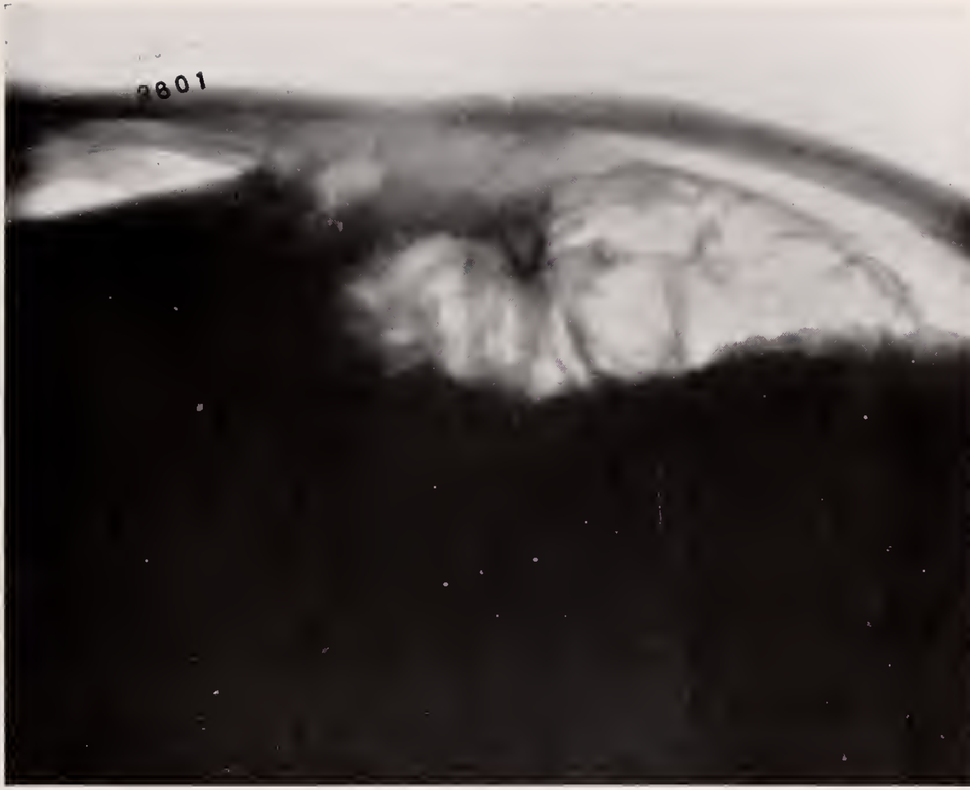
The observations in the peritoneoscope show the uterus to be darker in color. The oviduct showing evidence of injection of the subperitoneal vessels. Fixation by peritoneal adhesions along the broad ligament and adhesions between the fimbricated end of the oviduct and the ovary. The oviduct on the right side was absent. The ovary was small and grayish white in color.

Diagnosis: Chronic pyosalpyns with plastic adhesions fixing the fimbria of the left oviduct to the left ovary and broad ligament and the left lateral wall of the pelvis.

CASE 42. NO. 4194

The illustration is a lateral view. Patient lying face upward—hips elevated.

The purpose of this illustration is to show the peritoneoscope connected ready for observation in the region of the pelvis. The lamp and lens system may be completely withdrawn, leaving the cannula while further x-ray observations may be conducted and if necessary the lamp and lens system reintroduced again and further peritoneoscope observations made.



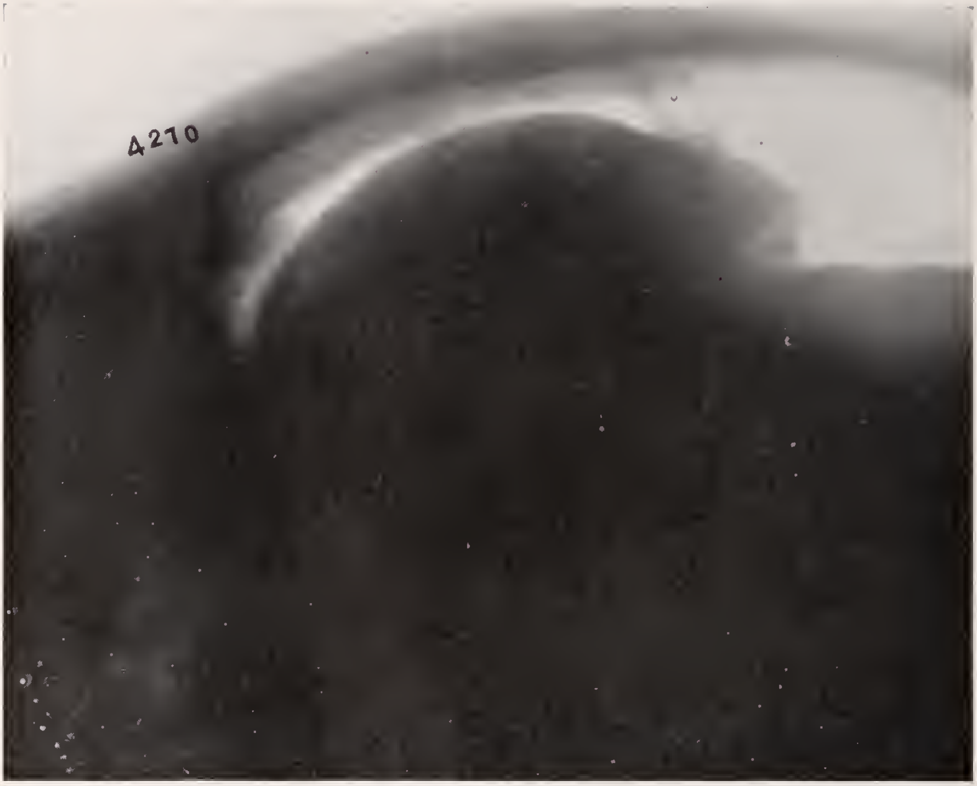
CASE 16. No. 3601

The illustration is a lateral view. Patient lying face upward. The patient had an cholecystotomy performed two years ago and has suffered great loss in weight with periods of high elevation of temperature and constant abdominal distress and constipation since the operation.

The oxygen appears between the liver and the anterior abdominal wall showing that no peritoneal adhesions of the liver exist except near the margin where it is seen to be fixed to the anterior abdominal wall. The liver appears as the straight line in the illustration beneath the point where the number plate is located. From the attachment of the liver distalward very dense accumulations of intestines appear in the illustration and but a small amount of oxygen is seen beneath the wall of the abdomen. There is much evidence of gas in the intestines. The intestinal mass is also adhered to the anterior abdominal wall for some distance near the point where the liver is attached.

The peritoneoscope showed the presence of small quantity of exudate creamy in character. The peritoneum was without lustre and there was but very little evidence of blood vessels except on the anterior abdominal wall. Certain areas of the peritoneum were studded with typical tubercles. Observations were conducted under great difficulty because of the small space existing between the intestines and the anterior abdominal wall.

The diagnosis was tubercular peritonitis with plastic exudate comprising peristalsis in the intestines, extensive peritoneal adhesions fixing the margin of the liver, the omentum and many loops of intestines beneath the side of the operation.



CASE 44. No. 4270

Illustration lateral view—patient lying face upward.

The history indicates the discovery of a tumor by the patient while bathing. There is small loss of weight, but practically no distress has been noted.

The tumor mass appears in the epigastrium and left hypochondrium. Physical examination failed to differentiate its origin.

The peritoneoscope showed the tumor mass to be an enlargement in the left lobe of the liver. The surface was of regular contour. Its color darker than the right lobe.

The x-ray observations show no evidence of fixation with any of the viscera. The small dense line appearing in the illustration between the anterior abdominal wall and the distal margin of the tumor is the falciform ligament. The upper margin of the tumor mass appears just below the line of the diaphragm.

Diagnosis: While the tumor could be definitely located as an enlarged left lobe of the liver, there were no findings which would determine the cause of its enlargement. There were no findings clinical or otherwise to indicate the cause of its enlargement.

Case 41. No. 4169

Illustration lateral view—patient lying left side upward—hips elevated.

History indicates menstrual period has been absent for the past three months. There is also a history of dysmenorrhea and menorrhagia for the past two years. The patient is at present suffering from more or less constant nausea and vomiting. Loss of weight and strength. Physical examination failed to show any abnormal complication of pregnancy in the pelvis.

X-ray observations after pneumoperitoneum had been produced shows mass somewhat larger than the menstrual period would indicate the uterus should be. The round ligament identifies very nicely the true uterine density.

The peritoneoscope shows the presence of a mass approximately the size of an orange behind the uterus. The mass was pale gray in color with a peritoneum showing the usual shiny appearance. The uterus was dark red in color. There was very little evidence of peritoneal adhesions.

Compare this illustration with Case 34. Without the peritoneoscope the diagnosis would be left in doubt.

The diagnosis was probably dermoid cyst with pregnancy. The diagnosis was confirmed by operation.

Case 51. No. 4477

The illustration is a lateral view. Patient lying left side upward—hips elevated.

The history indicates the presence of dsymenorrhea and periodical attacks of violent pelvic distress.

Physical examination failed to reveal the presence of any pathology in the pelvis.

X-ray observations after pneumoperitoneum had been produced show mass somewhat larger near the position of the pubis the proximal margin of the uterus with the small little line of the round ligament for identification.

Vaginal palpation and movement of the uterus assists greatly in detecting the uterus and the round ligament.

The illustration shows also a small circular density appearing just above the uterus and approaching the margin of the pelvis from the line of the ileo-sacral synchondrosis on the left side as far as the promontory. This mass could be observed on all sides when placed in different positions by vaginal palpation.

The peritoneoscope shows this mass to be somewhat irregular in contour and the usual appearance of ovarian cysts.

Diagnosis: Ovarian cyst. Operation confirmed the diagnosis.

Case 43. No. 4203

The illustration is lateral view. Patient lying right side upward and hips elevated.

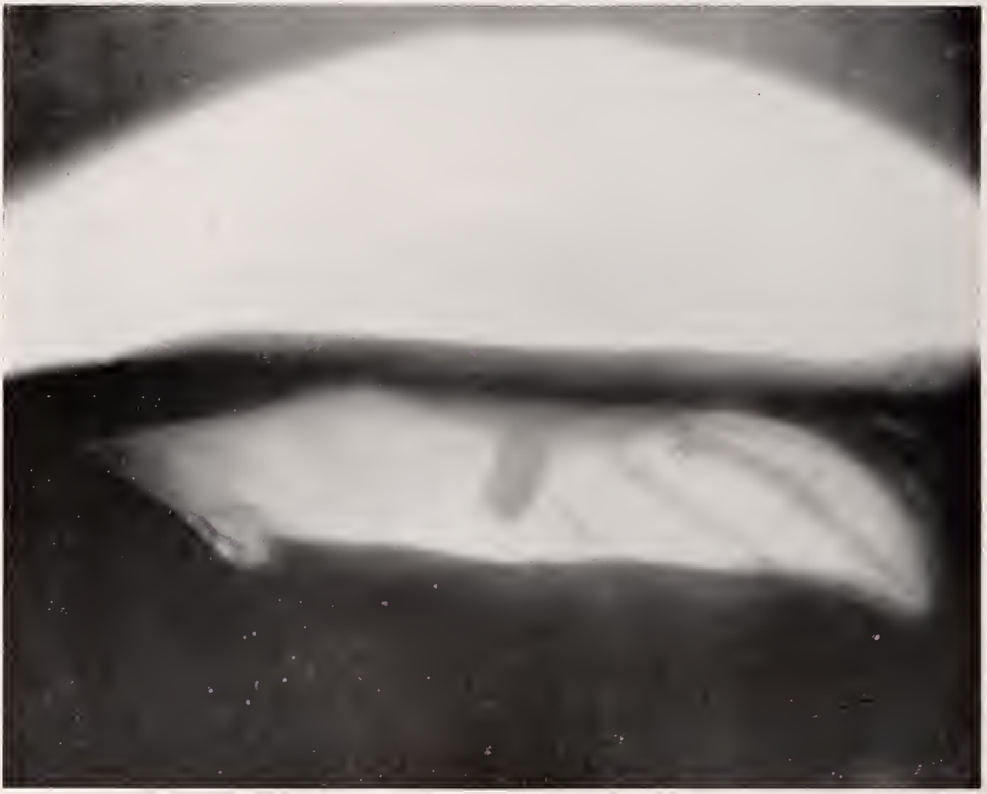
The history indicates the presence of tubercular spondylitis since childbirth. There is a marked right sided kyphosis. Patient has enjoyed good health for the past seven years until three months ago. Is losing weight and strength. Has daily afternoon elevation of temperature and some pelvic distress.

Physical examination shows no finding of importance other than the presence of tender areas.

X-ray observations after pneumoperitoneum has been produced show the uterus to be very small. Its identification from the confusing shadows of the distended bladder and loops of intestines to be uncertain except for the line of the round ligament which extends upward to the lateral wall in the illustration. Just proximal to the line of the round ligament a mass occurs, which appears under palpation to be fixed to the broad ligament and round ligament.

The peritoneoscope shows this mass to have the usual appearance of a cystic ovary. The peritoneum covering the oviduct, broad ligament and uterus seems pale, opaque and the usual glistening lustre is lost. A small number of typical tubercles were observed on the oviduct and lateral wall.

The diagnosis was localized tubercular peritonitis with adhesions fixing the right ovary and oviduct to the broad ligament and lateral wall.



CASE 21. No. 3630

The illustration is lateral view. Patient lying face upward.

The history shows evidence of digestive disturbance for the past seven years—exaggerated for the past three months. Distress immediately upon eating. Loss of weight and strength.

Physical examination elicits areas of extreme tenderness in the epigastrium. No tumor mass. Barium meal shows constant filling defect in the stomach near the pylorus and the absence of a normal duodenal cap.

The peritoneoscope shows the presence of small metastasis in the peritoneum over the surface of the liver and in the gastro-colic omentum. The falciform ligament appears as a dense infiltrated cord larger than a finger, for some distance away from the anterior abdominal wall, at which point it becomes a thin membrane, whose peritoneum shows the usual glistening appearance.

Diagnosis: Malignant metastasis from gastric carcinoma involving the stomach, duodenum, liver, omentum, etc.

CASE 34. No. 4040

Illustration is lateral view—patient lying left side upward—hips elevated.

The history indicates menstruation absent for the past three periods.

The oxygen fills the true pelvis and the pelvic brim may be clearly outlined. The uterine density is nicely identified by the presence of the round ligament. The size of the uterus as compared with the pelvic corresponds favorably to approximately the fourth month of pregnancy. The contour is regular and the shape and position are normal.

Contrast the shape with Case 41 which is not normal.

Diagnosis: Normal pregnancy approaching the fourth month.

ORAL INFECTION IN ITS RELATION TO SYSTEMIC DISEASES*

Rex L. Diveley, M. D.
and
W. W. Duke, M. D.

Our work on this subject was started in 1915, and since that time we have taken routine dental films on every patient who came into our hands. The series comprised some 1800 cases. Each patient received a thorough physical, laboratory and roentgen examination, so we feel certain that every focus of infection was excluded. The following statistics based on this series of cases may be of interest. It was found 84% of these patients had some form of oral sepsis. Of the poorly filled root canals, 88% showed shadows, 32% of which were extremely small and 56% of the shadows were of such size and appearance as to leave little doubt concerning the diagnosis of sepsis. In teeth showing relatively well filled canals the per cent was very low. It is interesting to note that of all the crowned teeth examined, in which an attempt had been made to leave the root pulp vital, 65% were shadowed. In 42% the shadows were very small and in 23% one could be secure in making a positive diagnosis of a root end infection. 93% of the snags of teeth left by decay or after faulty extraction were shadowed.

It will be noted that those figures are much higher than the excellent statistics collected by Black but we must bear in mind that his cases were collected from healthy individuals while our series were all suffering from one or more maladies.

I shall not confine my remarks to oral infection only, but shall discuss focal infections in general.

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*Read before Omaha Roentgen Society, March 27, 1920.

Multiple Infection

It is more or less generally recognized that if a person has two or more infectious diseases, one may influence the other occasionally to the apparent advantage of the patient but more frequently to his disadvantage. In other words, resistance to one organism may occasionally be increased by infection with another but usually the reverse is the case; that is, resistance to one organism is lowered by infection with additional organisms. This subject has been dealt with briefly in the literature under such titles as mixed infection, secondary infection, and focal infection, but not to the extent which it deserves. The fact has been mentioned, particularly by physicians specializing in the treatment of tuberculosis, who emphasize the fact that latent tuberculosis may become active and rapidly progressive after an attack of influenza, tonsilitis, measles, pneumonia, or other acute infectious diseases. Osler mentioned in some of his earlier writings that quiescent maladies, such as congenital syphilis and tuberculosis, may be lighted into activity by vaccination against smallpox. The army medical corps almost unanimously recognized that acute infections following such maladies as measles, mumps, influenza, etc., were more than doubly serious. One of us has been interested in this subject for a number of years and has observed many and varied examples of latent and chronic infection becoming acute and severe after an attack of an acute infection of a totally different nature. For example, in one patient a urethral discharge in which gonococci were abundant was noticed a few days after a severe attack of tonsilitis. The patient gave a history of having had urethritis two years previously but since that time had apparently been well and had not been exposed to fresh infection. Chronic cytitis of a mild type may become very severe following an attack of diarrhea, cholecytitis, appendicitis, or tonsilitis. Latent syphilis may become active following an acute febrile disorder. A patient with this disease who had

been thoroughly treated by one of us and who had been apparently well for several years was covered with a copper colored papillary rash and gave a positive Wassermann test at the end of the first week of convalescence from typhoid fever. Another somewhat analogous example was that of a patient who had an attack of pneumonia following an acute alveolar abscess. Several weeks later he had a recurrence of pulmonary tuberculosis that had been latent for many years and which had not interfered with a most active mental and physical life.

Chronic infections of a milder nature may also have a deleterious influence on other infectious diseases with which a person may be afflicted. This influence is often quite marked. The ill effect of chronic infections of the nose and throat on persons with tuberculosis is generally recognized and proper local measures for the cure of these are looked on as an important part in the regime for treating tuberculosis in many institutions. Oral sepsis may have an important influence on tuberculosis, and the eradication of oral sepsis may be of material value in arresting the progress of the disease.

Staphylococcic infections of the skin, such as acne and chronic furunculosis, according to Sutton, are often more amenable to treatment after the eradication of infected tonsils, alveolar abscesses, etc. In a patient observed by the writers with staphylococcus aureus septicemia of more than two months' duration, the temperature fell to normal a few hours after the extraction of an infected tooth and remained normal for ten days. The case eventually ended in complete recovery. The roots of the tooth showed streptococcus viridans in almost pure growth when cultures were taken, while repeated cultures of the urine and two blood cultures gave a growth of staphlococcus aureus.

One chronic mild infection may influence the course of other chronic mild infections. For example, tonsils that appear to be chronically inflamed often become smaller and appear relatively normal after the eradication of severe

oral sepsis. Chronic infection of the nasal sinuses may often be reduced in severity or to apparent quiescence by the removal of infected tonsils or alveolar abscesses. Symptoms of mild infection in the gall bladder are often relieved to a marked extent by the removal of apparently trivial infections in the nose, throat, or mouth. A patient, observed by the writers, who had been subject to recurrent attacks of slight jaundice associated with slight fever and pain in the region of the gall bladder for several years and who refused operation, has been relieved for two years by the extraction of one abscessed tooth. An analogous example is that of a patient who was subject to repeated attacks of gingivitis, which had caused a moderate grade of destruction of the gum margin. The attacks were difficult to account for because the teeth were regular, occlusion nearly perfect, and he had only one small filling in a nearly perfect set of teeth. This recurrent inflammatory process had resisted careful treatment by a capable dentist until an abscess pyorrheal in origin was discovered about one of the molar teeth. When this was extracted the gingivitis disappeared practically without further treatment and the patient's general health improved. Persistent cases of pyorrhea often yield more rapidly to treatment after the removal of chronically infected tonsils or after the extraction of abscessed teeth. Numerous similar examples with which careful observers are familiar could be mentioned.

It seems worth while at this point to make special mention of the relationship between acute or chronic sepsis and the symptomatology of syphilis, for antispecific treatment has a decidedly bad influence on pyogenic infections; on the other hand, pyogenic infections have an influence on the course of a specific disease which is so marked that physicians who neglect it are not accomplishing the maximum amount of good in their therapy. For this reason, syphilis and chronic sepsis form an unfortunate combination of diseases unless each infection is taken seriously and handled energetically.

The problem of multiple infection and the relationship which one infection bears to another is deeper and of greater interest than the simple fact that a person bombarded by two or more infections is worse off than he who has only one. One infection has an interesting relationship to other infections with which a person may be afflicted and it is believed may be explained in part at least through phenomena described under the terms allergy, protein sensitization, and anaphylaxis.

A true toxin is not formed by any of the micro-organisms that ordinarily take part in the pathology of infection in human beings with the exception of tetanus and diphtheria bacilli. Killed cultures of all other organisms or extracts of the organisms, or the culture medium in which they have grown, may be injected in large quantities into healthy guinea-pigs without immediate gross ill effect. They differ strikingly in this respect from tetanus and diphtheria bacilli, each of which produces a true toxin that is poisonous in high degree when administered subcutaneously even in very minute doses to animals. The products formed by other organisms that cause disease may be extremely toxic, however, through an entirely different mechanism, namely, the development in an individual of a condition known as allergy. This term, introduced by Pirquet, is used to designate the changed condition of human beings or animals, caused by infectious diseases or produced by inoculation with alien proteins, which causes the individual to react in a peculiar way if the bacteria responsible for the infectious disease or if the protein with which he may have been inoculated is reintroduced into the circulation. The ensuing reaction is in some respects protective and beneficial but in other respects may be harmful and even dangerons.

Persons with chronic furunculosis may give a general reaction within a few hours if they are inoculated with an excessive quantity of killed staphylococci and the furuncles may be made temporarily worse. Such persons react similarly when they are subjected to the effect of an increased

number of living bacteria due to the development of a fresh furuncle. This often causes both a general and a focal reaction. For example, with the development of a fresh furuncle there may appear fever, malaise, etc. (general reaction), and exacerbation in the inflammatory process in recent furuncles (focal reaction). In fact signs of activity, such as itching and redness, may appear in the scars of recently healed furuncles. This may be followed by a discharge of pus containing staphylococci aureus. These well known principles are true of infection in general and can be used in the explanation of many interesting phenomena. It is believed it can explain the fact that with the onset of a new infection signs of irritation and inflammation may appear within a few hours at remote points. For example, suppose an individual who had a latent streptococcic cholecytitis should have an attack of acute streptococcic tonsillitis. We would expect theoretically that a focal reaction in the gall bladder would follow which would give rise to the symptoms resembling gall bladder infection. Likewise if such an individual had abscessed teeth one would expect repeated reactions in the gall bladder therefrom and symptoms resembling chronic gall bladder infection. Further more, removal of the tonsils or infected teeth might remove the source of focal reactions in the gall bladder and lead to an amelioration of the gall bladder symptoms.

The relationship of allergy to primary foci of infection is interesting not only from the standpoint of the influence which primary foci of infection play on the secondary foci but also from the standpoint of the influence which the secondary foci play on the primary. For example, if an individual has pyorrhea or recently treated or apparently cured pyorrhea what would be the effect of an attack of cholecytitis on the gums. Theoretically an allergic reaction could occur in the gums which would give all the clinical signs of recurrence of gingivitis or pyorrhea and could cause a recurrence of this disease. Practically it might be said that this very thing often arises. It has been observed

by one of us a number of times. One patient subject to recurrent attacks of gingivitis could attribute nearly every recurrence to a cold followed by frontal and ethmoid sinus infection.

It is by no means uncommon to observe pain in the region of the gall bladder, appendix, stomach, joints, cervical glands, etc., a few hours after the extraction of infected teeth. Such may frequently be interpreted as focal reactions caused by the traumatic dissemination of microorganisms or their products from the alveolar process.

Frequently the clinical manifestations of chronic appendicitis, cholecytitis, gastric and duodenal ulcer, chronic arthritis, etc., clear up to a marked degree after the extraction of diseased teeth, even though the first effect may have been an increase in the inflammatory processes. Occasionally chronic inflammatory conditions that appear to indicate the need of surgical interference and serious internal diseases that cannot be reached by therapeutic agents partially or wholly clear up symptomatically after as simple a procedure as the extraction of a tooth or the removal of a pair of diseased tonsils. The relief can often be attributed to the fact that sources of bacterial products that have been continuously causing focal reactions in the infected regions have been removed.

This explanation applies very nicely to multiple infection when each lesion is caused by the same micro-organism. It may or may not apply in part to multiple lesions caused by different micro-organisms. This question is an open one about which much might be said. For example, if a person has streptococcic tonsilitis, a latent streptococcic infection in the joints and in the gall bladder, it would be in harmony with the accepted theories if an acute exacerbation of the tonsil infection were followed in a few hours by a reaction in the joints and gall bladder that caused pain and other phenomena of a focal reaction. This explanation, as previously mentioned, would not apply in the same way to multiple infections with the various lesions caused by

different micro-organisms, because sensitization against the protein of an infecting organism is thought, and we believe correctly so, to be more or less specific. Whatever the theoretical explanation may be, we have this fact, which is beyond dispute; infection with one micro-organism may lower the resistance against other organisms of different character to a degree that is by no means negligible.

I believe that the dental and medical professions are in harmony on the foregoing facts—and the only difference of opinions at this time is the treatment to be employed. Now, I don't feel that we, as medical men, should dictate to our dental brothers just what treatment they should employ, but I do feel that we should coöperate with them in every way possible. The physician is responsible for the treatment of his patient—and when oral sepsis is a complication, I think he should be held accountable for the proper eradication of same. With that view in mind, we have followed up the treatment in this series of cases in order to determine the proper measures for each individual case.

We have divided the apical infections into two classes:

First—The small apical granuloma or abscess which has eroded very little of the peri-dental membrane.

Second—The rather extensive infection which has eroded the peri-dental membrane as well as the alveolar process.

Now, in considering the treatment of these apical types of infection, we must take into account the health of the individual. If the patient is suffering with a malady of any kind, I feel that every infected tooth, no matter how small the infection, should be extracted. On the other hand, if the individual is fairly healthy, we have three types of proved treatment which may be advised. First—for the small infections of class one. A resterilization of the canal and a proper filling to the apex will eradicate the infection and normal bone will be found around the apex in from two to six months. We find this to be true in about 75% of cases. You will remember the tooth gains its blood supply through two sources, *i. e.*, through the canal artery and

through the peri-dental membrane. Thus when the canal artery is destroyed by a filling and the peri-dental membrane is destroyed by an infection, we have a tooth absolutely devoid of blood supply. This kind of a tooth is a foreign body in the mouth and is of no more value than a peg which might be driven into the alveolar process.

We suggest two ways of dealing with this class of case—first, extraction which we strongly advise; second, a properly filled root canal followed by an apicoectomy extracting the dead portion of the tooth. By this method we have removed the foreign body and the blood supply may then take care of the small amount of infection which might remain.

THE JOURNAL OF RADIOLOGY

PUBLISHED EVERY MONTH AT IOWA CITY, IOWA

THE JOURNAL OF RADIOLOGY is the official publication of the Radiological Society of North America, and is published monthly under the authority of the Society.

Subscription prices, per annum in advance, including postage: Domestic, $5.00; Foreign, $6.50.

Domestic rates include United States, Cuba, Mexico, Hawaii, Guam, Porto Rico, Canal Zone and Philippines.

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OMAHA ROENTGEN SOCIETY

The annual meeting of the Omaha Roentgen Society occurred March 27, 1920. The program was exceptionally well arranged. Early in the morning clinics were held by those in charge of the departments of the local medical schools. The material selected for demonstration was exceptionally interesting and was indeed one of the most attractive features of the entire program. These clinics were well attended and the writer believes this feature should receive more attention by those in charge of the program committee than has been customary in the arrangement of such meetings in the past.

The scientific program began at ten o'clock. The large banquet hall at the Fontanelle Hotel provided ample space and splendid facilities and the committee on local arrangements is to be commended for furnishing such excellent quarters.

The program committee provided four papers during the forenoon session, allowing but thirty minutes for each paper and its discussion.

At noon the Society were guests of the Chamber of Commerce. During the luncheon an address was given by Dr. Joseph Colt Bloodgood. The theme of the address was very aptly chosen and forcefully delivered.

The afternoon session was called to order at two o'clock. Five presentations were provided for the afternoon. These papers were delivered with the same degree of snap and interest as characterized the forenoon session. The meeting adjourned at 5:30 o'clock and reassembled for the banquet at 6:30 o'clock. A splendid musical program was rendered during the banquet. At the close of the banquet, the final presentation was given by Dr. Joseph Colt Bloodgood of Baltimore. His subject, "Roentgen Diagnosis of Bone Tumors," covers one of the most interesting subjects in the

realm of medicine for the roentgenologist. This presentation gave evidence of the years of time and effort required for its preparation and its publication must stand as a landmark of prograss in this great field.

The Omaha Roentgen Society is to be congratulated in being able to provide such a program for its annual meeting. It seems almost phenomenal that such a large scientific program can be arranged for and delivered without the absence of a single paper.

One of the features which has characterized the annual meetings of the Omaha Roentgen Society is the punctuality of their conduct. Every minute of the entire day was filled. The essayist was called at the time stated in the program in each instance.

The plate exhibits were well provided for with plenty of space and illumination. The manufacturers' exhibit commanded its share of interest as usual.

Abstracts

Carl Arthur Hedblom, M. D., Rochester, Minn. Foreign Bodies of Dental Origin in a Bronchus; Pulmonary Complications. Annals of Surgery, May, 1920, p. 569.

The use of the roentgen ray in all steps of diagnosis and treatment of dental foreign bodies in bronchi justifies a brief mention of this exhaustive paper. Fifty-two cases formed the basis of this report. Dr. Hedblom observed six. The foreign body was lodged in the right bronchus in twenty-one cases, in the left bronchus in nineteen, in both sides in one, and in the trachea in one; the location was not stated in ten.

The bodies were most frequent in the right lower lobe. In twenty-six cases the accident occurred under general anaesthesia; in twelve under nitrous oxide, in eleven under ether; in three under chloroform. In four cases the foreign body was inspired during dental operations without anaesthesia.

In sixteen uncomplicated the diagnosis was made by the roentgen ray; in five, in one the plate showed pleural thickening. In eight there was no mention of a roentgen examination.

Positive diagnosis is by means of:

1. History.
2. Roentgen ray, or
3. Bronchoscopy.

Twelve cases in this series were negative.

Examination by the roentgen ray is indispensable. A positive plate establishes a positive diagnosis, but a negative plate is not conclusive.

In sixteen uncomplicated cases the roentgen ray was

positive in six of the seven cases examined, but in the group with complications it failed to show the foreign body in twelve of the sixteen examined.

In indications for bronchoscopy the appearance in the roentgenogram of a foreign body or of any suspicious shadow leads all others.

Summary

1. Aspiration infection of the lungs is most common in operations about the mouth under anaesthesia.
2. Symptoms may be immediate or continuous, or there may be an intervening symptomless period of months or years.
3. Cough, dyspnoae, wheezing and pain in the chest are the most characteristic symptoms.
4. Late symptoms stimulate phthisis.
5. Positive diagnosis rests on history taking, roentgen ray and bronchoscopy.
6. Bronchoscopy for diagnosis is indicated in any early doubtful cases.
7. Spontaneous expulsion of foreign bodies is always uncertain.
8. Bronchoscopy is the only treatment to be considered in early uncomplicated cases. In cases where there is suppuration, thoracotomy gives the best results.
9. Death is due to abscess, bronchiectosis or gangrene, any one of which may be complicated by empyema.
10. Tuberculosis may coexist with a suppurative process.

John G. Clark, M. D. The Relative Values of Radium and Surgery in the Treatment of Tumors of the Pelvic Organs. Annals of Surgery, June, 1920, Vol. LXXI, pp. 683–696.

After five years of experience in the use of radium, radium may be considered an adjunct to surgery and not a competitor. Any therapy with the object of increasing the cures of cancer of the uterus is acceptable to the profession.

But surgeons are loath to give up any myoma uteri. In the Gynaecological Department of the University Hospital the operative mortality for hysterectomy in fibroids was two per cent. At the same time one hundred and ten cases have been radiated without any morbidity.

The number of harmless myomata is small. The danger of malignancy arising has been exaggerated. In eight hundred and fifty cases studied by Dr. C. C. Morris only four per cent cancers of the fundus have been found among myomatous uteri. If hemorrhage is present it favors benignancy. In carcinoma of the cervix hemorrhage favors malignancy. The one is periodic, abundant, the other constant and very small. The sympomatology is so positive that the selection of cases for radium treatment is practically safe.

Certain retrogressive changes are more valuable in the selection of cases. A simple liquefaction may be taken care of satisfactorily, but a true necrosis causes toxic symptoms, called cachexia, accompanied by asthenia. These toxic cases do better if treated by surgery than by radiation. Tumors larger than a three or four months' pregnancy are not radiated.

Sarcoma is seldom the degenerative process of myomata. In one thousand cases of supravaginal hysterectomy only one case is on record of a sarcomatous recurrence. In eight hundred and sixteen cases of myomata examined in the pathological laboratory only twenty-five sarcomatous ones were found. In any case radiation would be good treatment.

Cases Not Radiated

1. Tumors larger than three or four months' pregnancy.
2. Tumors associated with inflammatory lesions.
3. Patients who show toxic symptoms out of proportion to their anemia.
4. Coexistent abdominal lesions, as cholecystitis, cholelithiasis, appendicitis, etc.

Small tumors causing hemorrhages as their chief symptoms respond best.

Technic: The patient is prepared as for curettage. Nitrous oxide anaesthesia is administered, cervix dilated, uterus curetted if malignancy feared and fifty milligrams of radium are introduced. Results: Five days in the hospital, six weeks variability of flow, followed by slight vaginal discharge.

Menopause: The abrupt introduction of the menopause causes slightly more distress than in the normal course of events.

Failure to Relieve: In one hundred and fifty cases only four have not been relieved. It causes no increased difficulty in subsequent operation.

In young women radium is less frequently used because surgery may make it possible to prevent the menopause by leaving the ovaries. In two hundred cases time is proving permanent cures.

From 1914 to 1919 two hundred and nine inoperable cases have been treated. Of these seventy-three are living. Two have gone over the five-year period and are free from recurrence.

One brilliant result needs mentioning. A young woman in extremis, having twice been operated, has made a remarkable recovery from a decidoma malignum. This woman is alive and well after five years. Other cases are equally noteworthy.

Palliation is marked in even hopeless cases. Hemorrhage stops; in some never returns. This improves the physical and mental sides of the patient. Discharge and its malodorous effects are destroyed. Pain lessens, and is not so marked.

Two Possible Sequelae Charged to Radium

1. Acute proctitis follows in a few cases regardless of precautions taken, coming on a few days to three weeks after the treatment.

2. Nine rectovaginal and eight vesical fistulae have been

noted. All of these should not be charged to radium, as it frequently follows surgery, especially in carcinoma of the cervix. Fewer cases of fistula occur in the treated than untreated.

Questionable cases of malignancy should be treated with radiation because more cases will be saved with a lower immediate mortality. All definitely circumscribed malignant tumors with no ligament involvement should be treated surgically. Radium greatly supplants surgery.

Operation after radiation is not indicated; nothing is gained. Surgical intervention is too hazardous. Radiation may and should safely precede operation several days.

This study of two hundred and nine cases offers great encouragement. Cancer of the cervix may be taken from the domain of surgery and be transferred to the domain of radiation. Radium offers palliation and a possibility of cure.

Summary of Conclusions Two Years Ago in One Hundred Cases

1. As a palliative remedy radium is the treatment par excellence in inoperable cases of cancer of the cervix.

2. In operable cases they advocate a radical operation followed by post-operative radiation. In border-line cases they employ radium in preference to surgery.

3. In cancer of the fundus, even if far advanced, they perform hysterectomy.

Now we add a fourth: "As yet we claim no cures, but, based upon observation of a considerable number of inoperable cases which have remained locally healed from one to three years, we venture the hope that the quinquennial test will find several survivors."

John A. Lichty, M. D., Pittsburg. The Treatment of Thyroid and Other Endocrin Disturbances as Viewed by the Internist. American Journal of Medical Sciences, June, 1920.

The author approaches his subject with a reference to the

paucity of information on the endocrines. The discussion that follows reviews some of the literature and latest theories concerning the following organs of internal secretion.

1. Suprarenals and their specific secretions.
2. The thymus gland and its relation to thyroid disturbance.
3. The pituitary body and its secretion.
4. The pancreas and its internal secretion.

The importance of treatment of the thymus gland to clear up the symptoms of exophthalmic goiter is emphasized. He quotes Halstead as suggesting the coördination of the thymus and the thyroid glands as demonstrated by the autopsy reports, clinical courses, and the effect of roentgen treatment. Treating the thymus as well as the thyroid gives better results.

The disturbance of basal metabolism in hyperthyroidism is always marked. In some types it is more pronounced. But its estimation will always be a good criterion for the seriousness of the disturbance. The work of Du Bois has become so well recognized that it is now considered necessary to make a basal metabolism test before a diagnosis of hyperthyroidism is accepted.

Attention is called to the innervation of the thyroid gland, quoting Cannon thus: "The nerves distributed to the thyroid cells belong to the sympathetic and not to the vagal supply, and their effects are not indirect through alternations of blood flow; indeed they are true secretory nerves." The thyroid gland is subject to that division of the nervous system which is brought into action in emotional excitement and which causes adrenal secretion. The thyroid like the adrenals has functions which are performed in times of critical emergency.

There is a good practical test for determining, "Potential Hyperthyroidism". It is the use of adrenalin subcutaneously in doses of one-half cubic centimeter. Subsequent observations are made on the pulse rate, blood pressure, urinary secretion, blood sugar and objective and sub-

jective symptoms. This is called the Goetsch test. Experience with it shows an increasing regard for its practical character.

The cases are divided into four groups as follows:

Group 1. Those with no glandular enlargement but having hypo- or hypersecretion. Goetsch's test may be the only evidence. Surgery necessary. Medical treatment best. Roentgen treatment may be tried.

Group 2. The adolescent type. There are glandular enlargement and absence of symptoms. Enlargement is usually temporary. If any treatment is necessary it is medical. If symptoms develop roentgen ray may be applied.

Group 3. Those patients with enlarged thyroids and definite symptoms of hyperthyroidism.

The treatment should depend on the pathology. If surgery is indicated it should be applied. If roentgen rays, they should be used. In extremely toxic goiters medical treatment should be first and then surgery or roentgen ray treatment. Roentgen ray may be used as a preliminary to operation without any thought of subsequent operation. If tried it will often go so well that further resort to surgery will not be sought.

Group 4. Those patients having definite pathology of the thyroid without any disturbance in function. Examples: Malignant tumors, colloid goiter, simple goiter, cysts, etc. These are imperatively surgical, although simple and adenomatous goiters yield satisfactorily to roentgen treatment.

Treatment of goiters requires medical, surgical, and roentgen therapy. The author thinks the surgeon has a larger field, for he knows definitely what pathology he deals with.

Conclusions

1. Exophthalmic goiter or hyperthyroidism from other causes should be recognized early and treated promptly, on lines specified.

2. The earlier it is recognized the more likely will medical treatment suffice.

3. Neglected cases may require surgery or roentgen ray or both. Radium is included.

4. The roentgen ray treatment presents attractive advantages, but the indications for its use do not seem so definite yet, and results are not so certain.

5. In hyperthyroidism, the roentgenologist and the surgeon at best can only break through a vicious circle for which the internist may or may not have been responsible.

R. Atkinson Stoney, F. R. C. S. I., and Arnold K. Henry, F. R. C. S. I., Dublin, Ireland. Modern Methods in the Removal of Projectiles. Journal of Surgery, Gynecology and Obstetrics, June, 1920, Vol. XXX, pp. 621–625.

In 1918 in a hospital in France they used the fluoroscope and the direct method of removal of projectiles. The fluoroscope was the small French cabinet of Dr. Ledoux Lebard which had heavily insulated cables that did away with contact and shortening of the high tension current in the ordinary stationary fluoroscopes. This was put on wooden tracks under an aluminum operating table. The bonnet of Dessane was used when actually seeking the projectile. Either the operator or the assistant worked with it fastened to the head. It was surprising how easily the foreign bodies could be found and removed. The incisions required were small.

The only foreign body not removed was a small metallic substance on the aorta which gave no symptoms. The danger from roentgen burns was negligible, as the time required was never more than five minutes and the number operated not great.

Frank W. Lynch, M. D., F. A. C. S., San Francisco, Cal. The Pelvic Articulations During Pregnancy, Labor and the Puerperium. An X-ray Study. Journal of Surgery, Gyne-

cology and Obstetrics, June, 1920, Vol. XXX, pp. 575–580.

The question of girdle expansion in pregnancy and labor is an old one and recognized as settled. Numerous specific cases, in guinea pig, seal and cow are noted. References to medical history show how long it has been known to be present in the human being.

Duncan in 1867 summed up the problem thus: The sacro-iliac joints are movable in man and woman by position. In woman they soften during pregnancy and permit greater movability. In the first stage walking about spreads the pelvis. In the second stage the knees are drawn up, which permits greater spreading. The drawing of the abdominal muscles on the pubes and the pressure with the legs wide-spread cause an increased degree of separation in the pelvic outlet.

Deductions are difficult, but only one woman studied had a marked widening of the symphysis during pregnancy, with return to normal in fifteen months. Widening of the sacroiliac spaces was almost a constant phenomenon.

Arthur C. Heublein, M. D. Radium Treatment of Enlarged Thymus Glands in Infants. The American Journal of Roentgenology. April, 1920, Vol. VII, pp. 191–195.

Sudden deaths in infants may largely be explained by an overgrowth of the thymus tissue which occurs in the anterior upper mediastinal space. The roentgen ray is not only a valuable diagnostic agent but therapeutic as well. The author has been using radium in the treatment with unusually good results.

He states that eighty-four per cent of the patients presenting themselves to the Out-Patients Clinic of Dr. Benjamin's in one year were indisputable thymus cases. He has treated forty-one cases. His technique was cross-firing, with one hundred mg. of radium element filtered through 0.3 mm. silver, at half-inch skin tube distance through four portals of entry, placed over the anterior surface of the

thymus for two hours, making a total dosage of eight hundred hours. He is now using two hundred mg. and one-half the time. He has found that (1) Radium is a specific. (2) One treatment is sufficient. (3) It is easier than roentgen ray to apply in children. (4) His patients have not had a recurrence.

R. Walter Mills, M. D., and John S. Kimbrough, M. D., St. Louis. Radium Treatment of Cancer of the Esophagus under Roentgen Control. Journal of American Medical Association, June, 1920, Vol. 74, No. 23, pp. 1570–1576.

Cancer of the esophagus offers one of the most distressing pictures of suffering. The difficulties in deglutition and the symptoms arising from pressure in the mediastinum have not been relieved even by palliative treatment. The literature on treatment of cancer of the esophagus is brief. Einhorm, Exner, Janeway, Pinch, Chevalier Jackson, Hanford and Abbe are reported as having treated one or several cases each.

The histopathological changes are the same as the treatment of radium elsewhere. The physical law that the effectiveness of radium varies inversely as the square of the distance limits the usefulness. The beneficial effects on cancer elsewhere in the body makes its application in the esophagus logical. The situation of cancer in the esophagus makes centralization of application and protection difficult.

The technic is not standardized. The disease is desperate. One is justified in using heroic measures and patients are willing for them to be tried. Careful examination by the roentgen ray aids to plan the treatment. Observation by roentgen ray while placing the radium in the esophagus adds most effectively to the attempt at treatment. Esophagoscopy may add to the knowledge of the case, but its field of usefulness is diminished. The permanency of location of the radium and the outlines of the growth can not be determined. The usual control of the radium by means of the roentgen ray is unequaled by any other means.

Summary of Technic

1. Initial study of position and physical properties of the tumor by screen and plate, bismuth being used as an opaque media.

2. A preliminary injection of morphia and atrophine is given and then radium treatment is begun. This overcomes the distress of long treatment.

3. The radium is introduced the same as an esophageal bougie, in a wire applicator or encased in a stomach tube, anchored by the bridle bandage about the patient's head.

4. The radium used is 50 mg. and the time for initial treatment is six hours. The cases were treated from one to seven times.

Results

The immediate results were in most cases beneficial. No case failed to respond. Improvement began in twenty-four hours.

A gain in weight accrued in most cases. Functional improvement was greater than the anatomical. Dysphagia was the last unpleasant symptom to return.

Eleven cases were treated. No cures were expected or produced, though one is alive eighteen months after without signs of metastases. All cases were frankly advanced. Five cases have died. One died of perforation, probably from the effects of treatment. In six cases the dysphagia improved. In four more the swallowing was intermittently better. Life is undoubtedly prolonged. Most of the patients returned to work, and the morale was better.

Conclusions

The method of treating cancer of the esophagus by radium is hopeful.

Relief of dysphagia was the most marked sign of improvement.

The roentgen ray gives the most valuable aid to a knowledge of each case and serves as a guide in placing the radium.

A. F. Tyler, B. Sc., M. D., Omaha, Neb. Report of Four Cases of Malignant Disease Successfully Treated by Roentgen Therapy. American Journal of Roentgenology, 1920, Vol. VII, No. 5, pp. 231–233.

The author reviews his technique and cites four patients whose wonderful recovery proves the value of massive doses in deep therapy.

He favors one hundred and five to one hundred and fifteen K. V., six millimeters of aluminum and sole leather filter, working at an eight-inch anode skin distance. His time for each area varied from fifteen to twenty-five minutes. Correspondence with men giving deep therapy leads him to conclude that very few men are really giving deep therapy.

Case I. Carcinoma of the breast. Metastasis in liver, uterus and both breasts. In extremis treatment began December, 1915.

Results: Fourteen series of entire torso. For three years she has done her own work. At present the breast and abdomen are soft. The uterus is freely movable. The patient is apparently well.

Case II. May, 1918. Massive carcinoma of the cervix uteri, filling the pelvis. Results: Flow has ceased. Uterus normal in size and appearance and no glands palpable.

Case III. January, 1918. Entire pharynx filled with growth. Cervical glands involved. Results: Relief in two days. At present there is no evidence of growth or metastasis.

Case IV. Tumor of pituitary with destruction of the sella tursica; protrusion into the mouth. Results: Bulging has disappeared in the mouth. The sella is filling in. Eyesight much improved. No treatment since September, 1919.

W. Warner Watkins, M. D., Phoenix, Arizona. Pathological Findings on One Thousand Roentgen Ray Examinations of the Digestive Tract. American Journal of Roentgenology, 1920, Vol. VII, No. 5, pp. 234–246.

This report has three objects, *i. e.:*

1. To tabulate patients with chronic symptoms coming to the general practitioner.

2. To illustrate the importance of careful examinations in all gastro-intestinal roentgen examinations.

3. To demonstrate the frequency of certain lesions and combined lesions.

The report covers one thousand patients examined between May, 1916, and November, 1919. All come with symptoms or evidence of gastro-intestinal disease present.

The following tables are interesting for study.

Lesions Found in Patients with Indefinite Symptoms

(Number Examined, 400)

Negative (23%)	92
Chronic Appendix Disease only (22.5%)	90
Adhesions (colonic)	38
Combined Gall-bladder and Appendix Disease	30
Duodenal Ulcer	28
Gall-bladder Disease	27
Stomach Ulcer	18
Tuberculous Colitis	18
Appendix Disease with Stomach or Duodenal Ulcer	15
Ileocecal Adhesions	14
Diverticuli of the Colon	5
Cancer of the Stomach	5
Cancer of the Colon	4
Stomach Syphilis	2
Appendix and Gall-bladder Disease with Stomach Ulcer	2
Incompetent Ileocecal Valve	1
Gall-bladder Disease with Ulcer	1
Chronic Appendix with Ureteral Stone	1
Chronic Appendicitis with Duodenal Diverticulum	1
Negative Gastrointestinal with Spondylitis	1
Cancer of Lungs and Liver	1
Negative Gastro-intestinal with Kidney Stone	1
Duodenal Ulcer, Gall-bladder Disease with valve obstruction	1
Negative Gastro-intestinal with adhesive Pericarditis	1
Duodenal Ulcer with Tuberculous Colon	1
Infantile Pylorospasm	1
Gall Bladder Disease with Tuberculous Colon	1

Table II

Lesions Found in Patients Coming with Definite Symptoms of Stomach or Duodenal Disease

(Number Examined, 270)

Findings Negative (21.5%)	57
Duodenal Ulcer	57
Stomach Ulcer	42
Cancer of Stomach	30
Chronic Appendicitis	26
Gall-bladder Disease	17
Stomach and Duodenal Ulcer	8
Appendix Disease and Ulcer	7
Pylorospasm	4
Stomach Syphilis	3
Gall-bladder Disease and Appendicitis	3
Duodenal Diverticuli	3
Tuberculosis of the Colon	2
Ulcer and Gall-bladder Disease	2
Ulcer, Gall-bladder and Appendix Disease	2
Appendicitis and Diverticuli	1
Ulcer and Tuberculous Colon	1
Cancer of Esophagus	1
Negative Gastro-intestinal with Aneurism of Descending Aorta	1
Pyloric Stenosis	1
Diverticuli of Colon	1
Duodenal Ulcer and Stomach Cancer	1

Table III

Lesions Found in Patients with Symptoms of Gall-Bladder Disease

(Number Examined, 115)

Negative Findings (28%)	44
Gall-bladder Disease (55%)	78
Gall-bladder Disease with Appendicitis	8
Chronic Appendicitis	7
Duodenal Ulcer	6
Ulcer with Appendicitis	3
Stomach Ulcer	2
Gall-bladder Disease with Ulcer	2
Stone in Liver	1
Diverticuli of Colon	1
Negative Gastro-intestinal with Aneurism of Descending Aorta	1
Appendicitis plus Duodenal Diverticulum	1
Gall-bladder Disease, Appendix Disease with Ulcer	1

Table IV

Lesions Found in Patients with Symptoms of Appendix Disease

(Number Examined, 140)

Negative Findings (18%)	26
Chronic Appendicitis	88
Ileoceeal Adhesions	9
Appendix Disease plus Ulcer	4
Gall-bladder plus Appendix Disease	5
Gall-bladder Disease	2
Appendicitis with Tuberculous Colitis	2
Tuberculous Colitis	2
Stomach Ulcer, Gall-bladder Disease with Tuberculous Colitis	1
Chronic Appendix with Spondylitis	1

Table V

Lesions Found in Patients with Symptoms of Colon Disease

(Number Examined, 35)

Negative Findings	12
Colonic Adhesions	12
Incompetent Valve	4
Ileocecal Adhesions	2
Diverticuli of Colon	1
Chronic Appendix	1
Colitis	1
Enlarged Spleen	1
Appendix and Gall Bladder Disease	1

Operative findings for one hundred and forty-six patients were available. In thirty-five cases there was more or less disagreement. In one hundred and eleven cases the roentgen findings correctly foretold the operative findings. In ten of the thirty-five cases in which there was not agreement, only the gastro-intestinal tract had been examined.

Pathology was found in some other organ. In six the report was chronic appendicitis and the patient was operated at a later period for acute appendicitis.

In seven cases there was roentgen evidence of ulcer, but none was found at operation by palpation. The remaining twelve were clearly errors of the roentgenologists.

E. W. R.

VOLUME I FEBRUARY, 1920 NUMBER 2

THE JOURNAL OF RADIOLOGY

THE RADIOLOGICAL SOCIETY 1915

PUBLISHED BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

IOWA CITY, U. S. A.

VOLUME I MARCH, 1920 NUMBER 3

THE JOURNAL OF
RADIOLOGY

PUBLISHED BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

IOWA CITY, U. S. A.

VOLUME I APRIL 1920 NUMBER 4

THE JOURNAL OF RADIOLOGY

PUBLISHED BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

IOWA CITY, U. S. A.

VOLUME I MAY 1920 NUMBER 5

THE JOURNAL OF RADIOLOGY

THE RADIOLOGICAL SOCIETY
1915

PUBLISHED BY
THE RADIOLOGICAL SOCIETY
OF NORTH AMERICA

IOWA CITY, U. S. A.